KEITHLEY

Model 7001 Switch System Instruction Manual

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Manual Printing History

The printing history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information which the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this printing history page.

Many product updates and revisions do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, it is recommended that you review the Manual Update History.

Revision A (Document Number 7001-901-01).....November 1991
Addendum A (Document Number 7001-901-02) .....November 1991

Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture rear panel, or switching card.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC main. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a ⏚ screw is present on the test fixture, connect it to safety earth ground using #18 AWG or larger wire.

The ⚡ symbol on an instrument or accessory indicates that 1000V or more may be present on the terminals. Refer to the product manual for detailed operating information.

Instrumentation and accessories should not be connected to humans.

Maintenance should be performed by qualified service personnel. Before performing any maintenance, disconnect the line cord and all test cables.

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Medidas de seguridad

Se recomienda tomar las siguientes medidas de seguridad antes de usar este producto y cualquier instrumento asociado con él. Aunque, normalmente, algunos instrumentos y accesorios serán usados con voltajes no peligrosos, existen situaciones en que pueden haber condiciones peligrosas presentes.

Este producto está destinado a ser usado por personal calificado quienes entienden los peligros de los electrochoques y conocen las medidas de seguridad requeridas para evitar la posibilidad de sufrir lesiones. Leer detenidamente la información sobre manejo antes de usar este producto.

Tener mucho cuidado cuando exista peligro de electrochoque. Puede haber voltaje mortal presente en los conectores de cables o aparatos de prueba. El Instituto de Normalización Nacional (EE.UU.) (ANSI) especifica que existe peligro de electrochoque cuando hay presente niveles mayores que un voltaje cuadrado medio de la raíz 30 V, pico de 42,4V ó 60VCC. **Una buena medida de seguridad antes de usar el instrumento es estar consciente de la posibilidad de que haya voltaje peligroso en cualquier circuito desconocido.**

Antes de manejar el instrumento, asegurar que el cordón eléctrico esté conectado a un tomacorriente bien conectado a tierra. Antes de cada uso, inspeccionar los cables de conexión, los conductores de prueba y los cables puente en busca de posibles grietas, desgaste o roturas.

Para máxima seguridad, no tocar el producto, los cables del probador o cualquier otro instrumento mientras se aplica corriente al circuito que se está probando. SIEMPRE cortar la corriente del todo el sistema de prueba y descargar los capacitores antes de: conectar o desconectar cables o puentes, instalar o quitar tarjetas de conmutación, o hacer cambios internos, tales como instalar o quitar puentes.

No tocar ningún objeto que pudiera servir de paso de corriente al lado común del circuito que se está probando o la tierra de la línea de energía eléctrica. Siempre tomar las mediciones con las manos secas y situado de pie sobre una superficie seca y aislada capaz de resistir el voltaje que se está midiendo.

No sobrepasar los niveles de señales máximos de los instrumentos y accesorios, según lo definido en las especificaciones e información de manejo, y según lo indicado en el instrumento o panel trasero del probador, o tarjeta de conmutación.

No conectar las tarjetas de conmutación directamente a circuitos de energía ilimitada. Están destinadas a ser usadas con fuentes limitadas por impedancia. NUNCA conectar las tarjetas de conmutación directamente a la red de corriente alterna. Cuando se conecten fuentes de suministro a las tarjetas de conmutación, instalar dispositivos protectores para limitar la corriente de pérdida y el voltaje a la tarjeta.

Cuando se usen fusibles en un producto, reemplazarlos con el mismo tipo y capacidad del original para protección continua contra el peligro de incendio.

Las conexiones al chasis solamente deben usarse como conexiones de blindaje para los circuitos de medición, NO como conexiones a tierra de seguridad.

Si se está usando un probador, mantener la tapa cerrada mientras se aplica corriente al dispositivo que se está probando. El manejo seguro requiere el uso de un enclavamiento de la tapa.

Si hay un tornillo en el probador, conectarlo a una toma a tierra de seguridad utilizando un alambre calibre 18 AWG o mayor.

El símbolo en un instrumento o accesorio indica que hay 1000V o más presente en los terminales. Consultar el manual del producto para la información en detalle acerca del funcionamiento.

Estos instrumentos y accesorios no deben conectarse a humanos.

El mantenimiento debe hacerlo personal calificado. Antes de hacer cualquier tipo de trabajo de mantenimiento, desconectar el cordón eléctrico y todos los cables de prueba.

Precauzioni di Sicurezza

Le seguenti precauzioni di sicurezza devono essere osservate prima di usare questo prodotto o la strumentazione associata. Benchè alcuni strumenti ed accessori sarebbero normalmente usati con tensioni non pericolose, vi sono situazioni dove condizioni pericolose possono essere presenti.

Questo prodotto è inteso per uso da personale qualificato che riconosce il pericolo di scosse elettriche e che ha familiarità con le precauzioni di sicurezza richiesti per evitare la possibilità di ferite. Leggete attentamente le istruzione per l'uso prima di usare il prodotto.

Usate la massima cautela quando è presente il pericolo di scossa elettrica. Potenziali letali possono essere presenti sulle prese dei cavi o sulle attrezzature di prova. La American National Standards Institute (ANSI) indica che il pericolo di scossa elettrica esiste quando sono presenti livelli di tensione superiori a 30V di valore efficace, 42.4V tensione di picco, o 60V corrente continua. **Una buona prassi di sicurezza è di aspettarsi la presenza di tensione pericolosa in qualsiasi circuito ignoto prima della misurazione.**

Prima di azionare uno strumento, assicurate che il filo è collegato ad una presa adeguatamente collegata a terra. Ispezionate i cavi di collegamento, i conduttori di prova, e i ponticelli prima dell'uso per la possibilità di usura, spaccature, o rotture.

Per la massima sicurezza, non toccate il prodotto, i conduttori di prova, o qualsiasi altro strumento quando l'elettricità è applicata al circuito sotto prova. Distaccate SEMPRE l'elettrico dall'intero sistema di prova e scaricate i condesatori prima di collegare o distaccare cavi di collegamento o ponticelli, prima di collocare o distaccare cavi di commutazione, o prima di eseguire cambiamenti interni come installare o rimuovere ponticelli.

Non toccate qualsiasi oggetto che potrebbe fornire un percorso per la corrente al lato comune del circuito sotto prova o al conduttore di terra del cavo principale. Fate sempre le misurazioni con mani asciutte e stando in piedi su una superficie asciutta, isolata elettricamente e capace di resistere la tensione misurata.

Non eccedete i livelli massimi dei segnali degli strumenti e accessori, definiti dalle specifiche e le informazioni d'uso, o come indicati sul pannello posteriore dello strumento o l'apparecchiatura di prova, o sulla scheda di commutazione.

Non collegate schede di commutazione a circuti con potenza non limitata. Sono intese per uso con sorgenti a impedenza limitata. Non collegate MAI le schede di commutazione direttamente alla fonte principale di corrente alternata. Quando si collegano sorgenti elettriche alle schede di commutazione, collocate dispositivi per limitare correnti e tensioni annormali alla scheda.

Quando si usano fusibili in un prodotto, rimpiazzateli sempre con fusibili dello stesso tipo e limiti di impiego per la continuata protezione dal pericolo d'incendio.

Collegamenti alla struttura dello strumento possono essere usati come collegamenti schermo per misurare circuiti, NON come collegamenti di sicurezza a terra.

Se usate attrezzature di prova, tenete chiuso il coperchio mentre è applicata la potenza al congegno sotto prova. L'operazione sicura richiede l'uso di un coperchio con dispositivo di blocco.

Se sull'attrezzatura di prova è presente una vite , collegatela a terra usando un filo di diametro #18 AWG o oltre.

La presenza del simbolo su di uno strumento o accessorio indica che 1000V o oltre possono essere presenti sui terminali. Fate riferimento al manuale d'uso del prodotto per informazioni dettagliate di operazione.

La strumentazione e gli accessori non devono essere collegate alle persone.

La manutenzione deve essere eseguita da personale di servizio qualificato. Prima di eseguire la manutenzione, distaccate il cavo elettrico e tutti i conduttori di prova.

Consignes de sécurité

Les consignes de sécurité suivantes doivent être observées avant d'utiliser ce produit et toute instrumentation associée. Bien que certains instruments et certains accessoires doivent normalement être utilisés avec des tensions non dangereuses, il existe des situations dans lesquelles des conditions dangereuses peuvent être présentes.

Ce produit est conçu pour être utilisé par du personnel qualifié qui connaît les risques d'électrocution et qui est familier avec les consignes de sécurité à respecter pour éviter un risque de blessure. Lisez attentivement l'information de fonctionnement avant d'utiliser ce produit.

Soyez extrêmement prudent lorsqu'il y a risque d'électrocution. Une tension mortelle peut être présente sur les broches de connecteur de câble ou les dispositifs de test. La norme ANSI (American National Standards Institute) définit qu'un risque d'électrocution est présent lorsque les niveaux de tension présents sont supérieurs à 30 V efficace, 42,4 V max, ou 60 Vcc. **Une bonne consigne de sécurité est de supposer qu'une tension dangereuse est présente dans tout circuit inconnu avant de mesurer.**

Avant de faire fonctionner un instrument, assurez-vous que le câble d'alimentation est branché à une prise correctement mise à la terre. Inspectez les câbles de connexion, testez les fils et les cavaliers pour une usure, des fissures ou des cassures possibles avant chaque utilisation.

Pour une sécurité maximum, ne touchez pas le produit, les câbles de test ou tout autre instrument pendant que le circuit en cours de test est relié au secteur. Coupez TOUJOURS le courant pour le système de test entier et déchargez les capacités avant de brancher ou de débrancher des câbles ou des cavaliers, d'installer ou de retirer des cartes de commutation, ou de faire des changements internes, comme l'installation ou le retrait de cavaliers.

Ne touchez pas d'objet qui pourrait fournir un chemin pour le courant vers le côté commun du circuit sous test ou la mise à la terre du secteur. Faites toujours les mesures avec les mains sèches, en vous tenant sur une surface sèche et isolée capable de soutenir la tension en cours de mesure.

Ne dépassez pas les niveaux de signal maximum des instruments et des accessoires, comme défini dans les spécifications et informations de fonctionnement, et comme illustré sur le panneau arrière de l'instrument ou du dispositif de test, ou sur la carte de commutation.

Ne branchez pas les cartes de commutation directement sur les circuits de courant illimités. Ils doivent être utilisés avec des sources à impédance limitée. Ne branchez JAMAIS les cartes de commutation directement sur le circuit principal alternatif. Lors du branchement des sources sur les cartes de commutation, installez des dispositifs protecteurs pour limiter le courant de court-circuit et la tension sur les cartes.

Lorsque des fusibles sont usés dans un produit, remplacez-les par des fusibles du même type et du même ampèrage pour une protection continue contre les risques d'incendie.

Les connexions de châssis ne doivent être utilisées que comme connexions de blindage pour mesurer les circuits, PAS comme connexions de mise à la terre de sécurité.

Si vous utilisez un dispositif de test, gardez le couvercle fermé pendant que le courant est appliqué sur le dispositif en cours de test. Un fonctionnement sûr nécessite l'utilisation d'un verrouillage du couvercle.

Si une vis est présente sur le dispositif de test, branchez-la à la terre de sécurité en utilisant un fil de calibre 18 ou plus.

Le symbole sur un instrument ou un accessoire indique que 1000V ou plus peuvent être présents sur les terminaux. Reportez-vous au manuel du produit pour une information détaillée du fonctionnement.

L'instrumentation et les accessoires ne doivent pas être connectés à des humains.

L'entretien doit être effectué par du personnel de service qualifié. Avant d'effectuer un entretien, débranchez le cordon d'alimentation et tous les câbles de test.

Sicherheitsvorkehrungen

Folgende Sicherheitsvorkehrungen sind vor dem Gebrauch dieses Produktes und aller damit zusammenhängenden Instrumente zu beachten. Obwohl einige Instrumente und Zubehör normalerweise mit ungefährlicher Spannung laufen, sind Situationen möglich, in denen gefährliche Spannungen vorhanden sein können.

Dieses Produkt ist zum Gebrauch durch qualifizierte Fachkräfte gedacht, die Stromschlaggefahren erkennen und mit den erforderlichen Sicherheitsvorkehrungen vertraut sind, um Verletzungen zu vermeiden. Die Betriebsanweisungen sind vor dem Gebrauch des Produktes sorgfältig durchzulesen.

Im Falle einer Stromschlaggefahr ist äußerste Vorsicht geboten. An den Kabelverbindungssteckern oder den Prüfgeräten können die Spannungen tödlich sein. Nach dem American National Standards Institute (ANSI) besteht eine Stromschlaggefahr, wenn die Spannungswerte über 30V RMS, 42,4V Spitzenwert oder 60V Gleichstrom liegen. **Eine gute Sicherheitsvorkehrung ist, davon auszugehen, daß eine gefährliche Spannung in einem unbekannten Stromkreis besteht, bevor dieser gemessen wird.**

Vor Benutzung eines Instruments ist sicherzustellen, daß das Stromkabel in eine vorschriftsmäßig geerdete Steckdose eingesteckt ist. Anschlußkabel, Testdrähte und Brücken sind vor jeder Benutzung auf eventuelle Abnutzung, Risse oder Brüche zu überprüfen.

Jede Berührung des Produktes, der Testkabel und aller weiteren Instrumente vermeiden, während der zu prüfende Stromkreis mit Strom versorgt wird. Die Stromzufuhr zum gesamten Testsystem IMMER unterbrechen und die Kondensatoren entladen, bevor Kabel und Brücken angeschlossen oder getrennt, Schaltkarten installiert oder ausgebaut oder interne Veränderungen wie eine Installation oder der Ausbau einer Brücke vorgenommen wird.

Keinen Gegenstand berühren, der eine Leitung zum geprüften Stromkreis oder der Stromleitungsmasse (Erdung) darstellt. Alle Messungen mit trockenen Händen vornehmen und darauf achten, daß man auf einer trockenen, nicht leitenden Unterlage steht, die einen bei der gemessenen Spannung von Erde isoliert.

Die maximalen Signalwerte der Instrumente und des Zubehörs, die in den Spezifikationen und Betriebsinformationen sowie auf dem Instrument, der Rückseite des Prüfgeräts und der Schaltkarte angegeben sind, dürfen nicht überschritten werden.

Schaltkarten nicht direkt an unbegrenzte Stromkreise anschließen. Sie sind zum Gebrauch mit Impedanzschutz vorgesehen. Die Schaltkarten dürfen NIEMALS direkt an Wechselstrom angeschlossen werden. Bei der Verbindung von Schaltkarten mit Stromquellen ist darauf zu achten, daß Schutzvorrichtungen installiert werden, die Fehlerstrom und -spannung zur Karte auf ein Minimum beschränken.

Werden in einem Produkt Sicherungen benutzt, so müssen diese mit dem gleichen Typ und der gleichen Leistung ersetzt werden, um einer Brandgefahr vorzubeugen.

Chassisanschlüsse dürfen nur als Schutzanschlüsse zur Messung der Stromkreise und NICHT als Masse verwendet werden.

Bei der Benutzung eines Prüfgerätes muß der Deckel geschlossen sein, während das zu prüfende Gerät mit Strom versorgt wird. Ein sicherer Betrieb bedarf einer Deckelsperre.

Ist eine Schraube auf dem Prüfgerät vorhanden, so sollte diese mit Hilfe eines Drahtes Nr. 18 AWG oder eines stärkeren Drahtes an die Masse angeschlossen werden.

Das Symbol auf einem Instrument oder Zubehör weist darauf hin, daß eine Spannung von 1000 Volt oder mehr an den Anschlüssen vorhanden ist. Ausführliche Betriebsinformationen sind im Produkthandbuch zu finden.

Instrumente und Zubehör dürfen nicht mit Personen verbunden sein.

Die Wartung ist durch qualifiziertes Fachpersonal vorzunehmen. Vor Wartungsarbeiten das Stromkabel aus der Steckdose ziehen und alle Testkabel unterbrechen.

安全上の注意

以下に記載されている安全上の注意事項は、本製品および関連した機器を使用する前に、必ず確認してください。ある機器とアクセサリーは、通常危険のない電圧で使用されますが、危険な障害が存在するような状況下で使用されているかもしれません。

本製品は、危険な障害を認識でき、考えられる傷害を避けるために必要な安全上の注意に精通している、資格を備えた者によって使用することを意図しています。製品を使用する前に、必ず操作説明を読んでください。

障害が存在するときには、特別な注意を払ってください。致命的な電圧が、ケーブルの接続ジャックまたはテスト装置に存在しているかもしれません。米国標準協会(ANSI)は、電圧レベルが30V RMS、42.4Vピーク、また60VDCが確認されるときに障害が存在すると述べています。よい安全対策は、計測を行なう前にあらゆる未知の回路に危険な電圧が存在していると考えることです。

機器を使用する前に、ライン・コードが適切にアースされた電力コンセントに接続されていることを確認してください。毎回使用する前には、接続ケーブル、テスト・リード、ジャンパーに磨耗やヒビ、または故障がないかどうかを検査してください。

安全な作業を行なうために、テストが行なわれている回路に電力が適用されている間は、製品やテスト・ケーブル、または他の機器に触れないでください。ケーブルまたはジャンパーの接続および取り外し、スイッチング・ボードの設置または取り外し、ジャンパーの設置や取り外しのような内部の変更を行なう前には必ずテスト・システム全体から電力を除去してコンデンサーを放電してください。

テストが行なわれている回路のコモン側または電力ラインのアースへ電流の道を提供することになりかねない物体には触れないでください。常に、計測が行なわれる電圧に耐えることができるように絶縁されている乾燥した表面に立ち、乾いた手で計測を行なってください。

スペックと操作説明に定義されている、また機器またはテスト装置の後部パネルまたはスイッチング・カート上に示されている、機器およびアクセサリーの最大信号レベルを越えないでください。

無制限の電力回路にスイッチング・カードを直接接続しないでください。カードはインピーダンスによって制限されたソースと共に使用するよう意図されています。決してスイッチング・カードを直接AC メインに接続しないでください。ソースをスイッチング・ボードに接続するときは、カードへの誤った電流と電圧を制限するための保護装置を設置してください。

製品にヒューズが使用されているときは、火災障害に対する予防として、同じタイプおよびレートのものと交換して下さい。

本体のコネクションは、安全対策のアース接続としてではなく、回路計測のためのシールド・コネクションとしてだけに使用されるべきです。

もしテスト機器を使用しているならば、テストが行なわれている装置に電力が提供されている間、フタを閉めてください。安全性を確実にするには、フタのインターロックを使用します。

もし ⏚ スクリューが機器に装備されている場合は、#18AWGまたはラージ・ワイヤーを使って、これをセーフティー・アース・グラウンドに接続します。

機器またはアクセサリーの ⚡ シンボルは、ターミナル上に1000Vまたはそれ以上の電圧が存在することを示しています。詳細な操作説明については、製品の取り扱い説明書を参照してください。

機器およびアクセサリーを人体に接続しないで下さい。

メインテナンスは、有資格のサービス要員によって行なわれるべきです。メインテナンスを実行する前には、ライン・コードとすべてのテスト・ケーブルを取り外して下さい。

MODEL 7001 SWITCHING MAINFRAME

SYSTEM

CAPACITY: Two plug-in cards per mainframe.

MEMORY: Battery backed-up storage for 100 switch patterns.

SWITCH SETTLING TIME: Automatically selected by the mainframe for each card. Additional time from 0 to 99999.999 seconds can be added in 1ms increments.

TRIGGER SOURCES:

External Trigger (TTL-compatible, programmable edge, 600 ns minimum pulse, rear panel BNC).

IEEE-488 bus (GET, *TRG)

Trigger Link

Manual (front panel)

Internal Timer, programmable from 1ms to 99999.999 seconds in 1ms increments.

STATUS OUTPUT: Channel Ready (TTL-compatible signal, rear panel BNC). Low going pulse (10µs typical) issued after relay settling time. For two different switch cards, 7001 will be set to the slowest relay settling time.

SWITCHING SEQUENCE: Automatic break-before-make.

MAINFRAME DIGITAL I/O: 4 Open collector outputs (30V maximum pull up voltage, 100mA maximum sink current, 10Ω output impedance), 1 TTL compatible input, 1 common.

RELAY DRIVE: 700mA maximum for both card slots.

CARD SIZE: 32mm high × 114mm wide × 272mm long (1.25 in. × 4.5 in. × 10.75 in.).

CARD COMPATIBILITY: Fully compatible with all 705, 706, and 7XXX cards.

THROUGHPUT

EXECUTION SPEED OF SCAN LIST: 200 channels or memory locations per second.

TRIGGER EXECUTION TIME (maximum time from activation of Trigger Source to start of switch open or close[2]):

SOURCE	LATENCY	JITTER
GET[1]	400 µs	<100 µs
*TRG[1]	5.0 ms	
Trigger Link	400 µs	< 13 µs
External	400 µs	< 13 µs
Timer	400 µs	< 13 µs

[1] Assuming no IEEE-488 commands are pending execution.

[2] Excluding switch settling time.

IEEE-488 COMMAND EXECUTION TIME

COMMAND	EXECUTION TIME[1]
:ROUT:OPEN (@1!1)	< 29 ms + Relay Open Time
:ROUT:CLOS (@1!1)	< 29 ms + Relay Close Time
:ROUT:MEM:REC M1	< 32 ms + Relay Settle Time

[1] Measured from the time at which the command terminator is taken from the bus to relay energize.

ANALOG BACKPLANE

SIGNALS: Four 3-pole rows (Hi, Lo, Guard). These signals provide matrix and multiplexer expansion between cards within one mainframe.

MAXIMUM VOLTAGE: 250V DC, 250V RMS, 350V AC peak, signal path to signal path or signal path to chassis.

MAXIMUM CURRENT: 1 A peak.

PATH ISOLATION:

$>10^{10}\Omega$, <50 pF path to path (any Hi, Lo, Guard to another Hi, Lo, Guard).

$>10^{10}\Omega$, <50 pF differential (Hi to Lo or Hi, Lo to Guard).

$>10^{9}\Omega$, <75 pF path to chassis.

CHANNEL CROSSTALK: < -65 dB @ 1 MHz (50 ohm load).

BANDWIDTH: < 3 dB loss at 100 MHz (50 ohm load).

IEEE-488 BUS

STANDARDS CONFORMANCE: Conforms to SCPI-1990, IEEE 488.2 and IEEE 488.1.

MULTILINE COMMANDS: DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD.

UNILINE COMMANDS: IFC, REN, EOI, SRQ, ATN.

INTERFACE FUNCTIONS: SH1, AH1,T5, TE0, L4, LE0, SR1, RL1, PP0, DC1,DT1, C0, E1.

GENERAL

DISPLAY:

Dual line vacuum fluorescent.

1st line: 20-character alphanumeric.

2nd line: 32-character alphanumeric.

REAR PANEL CONNECTORS:

IEEE-488

8-pin micro DIN connector for digital I/O

8-pin micro DIN for Trigger Link

8-pin micro DIN for Trigger Link expansion

BNC for External Trigger

BNC for Channel Ready

POWER: 90-260VAC universal input, 47-440 Hz, 40VA maximum.

SAFETY: Designed to meet UL 1244, IEC 348.

EMI/RFI: Meets VDE 0871B and FCC Class B.

ENVIRONMENT:

Operating: 0°C to 50°C, <80% relative humidity (0°C to 35°C).

Storage: -25°C to +65°C.

DIMENSIONS, WEIGHT: H 89mm, W 216mm, L 375mm, 3.4kg (H 3.5", W 8.5", L 14.8", 7.5lb).

Specifications subject to change without notice.

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Basic Operation

1 General Information

1.1 Introduction

This section contains general information about the Model 7001 Switch System.

1.2 Features

1.3 Warranty Information

1.4 Manual Addenda

1.5 Safety Symbols and Terms

1.6 Specifications

1.7 Inspection

1.8 Optional Accessories

1.2 Features

Some important Model 7001 features include:

- High Density Switching — Up to 80 channels per mainframe using two switching cards.
- Switching Cards — In addition to the switching cards designed specifically for the Model 7001 (i.e. Models 7011, 7012 and 7013), you can use the switching cards that were originally designed for the Keithley Models 705 and 706 scanners.
- Analog Backplane — Can be used to internally connect the rows or banks of a Model 701X series card installed in one slot to the rows or banks of a second Model 701X series card installed in the other slot.
- Close/Open or Scan — The Model 7001 can simply close and/or open one or more channels, or scan through a specified list of channels.
- Channel Status Display — The real-time status display monitors the state (closed or open) of all available channels.
- Memory — Up to 100 channel patterns (pattern of open and closed channels) and 10 customized instrument setups can be saved in memory for later recall.
- IEEE-488 Bus — Bus operation conforms to the IEEE-488.2 and SCPI standards.
- Trigger Link — New trigger concept to provide more versatile and precise external triggering. This is in addition to the standard in/out BNC external triggering technique.

1.3 Warranty information

Warranty information is located on the inside front cover of this instruction manual. Should your Model 7001 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the instrument for repair, be sure to fill out and include the service form at the back of this manual in order to provide the repair facility with the necessary information.

1.4 Manual addenda

Any improvements or changes concerning the instrument or manual will be explained in an addendum included with the manual. Be sure to note these changes and incorporate them into the manual.

1.5 Safety symbols and terms

The following symbols and terms may be found on an instrument or used in this manual.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the instruction manual.

The symbol on an instrument shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the scanner card. Such damage may invalidate the warranty.

1.6 Specifications

Model 7001 specifications may be found at the front of this manual.

1.7 Inspection

The Model 7001 was carefully inspected, both electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit. Report any damage to the shipping agent immediately. Save the original packing carton for possible future reshipment. The following items are included with every Model 7001 order:

- Model 7001 Switch System
- Model 7001 Instruction Manual
- Model 8501-1 Trigger Link Cable
- Additional accessories as ordered.

If an additional instruction manual is required, order the manual package, Keithley part number 7001-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.8 Optional accessories

The following accessories are available from Keithley for use with the Model 7001.

Model 4288-1 Single Fixed Rack Mount Kit; mounts a single Model 7001 in a standard 19-inch rack.

Model 4288-2 Dual Fixed Rack Mount Kit; mounts two Model 7001s side-by-side in a standard 19-inch rack.

Model 4288-3 Dual Fixed Rack Mount Kit; mounts one Model 7001 and a Model 199 DMM side-by-side in a standard 19-inch rack. Model 8501 Trigger Link Adapter; allows you to connect the Trigger Link of the Model 7001 to an instrument that uses the standard BNC (In/Out) external triggering technique.

Models 8501-1 and 8501-2 Trigger Link Cables: The Model 8501 is one meter in length, and the Model 8501-2 is two meters in length.

Model 7007 Shielded IEEE-488 Cables: Connects the Model 7001 to the IEEE-488 bus using shielded cables to reduce electromagnetic interference (EMI). The Model 7007-1 is one meter in length and has an EMI shielded IEEE-488 connector at each end. The Model 7007-2 is identical to the Model 7007-1, but is two meters in length.

2

Card Installation

ATTENTION FIRST TIME USERS

If you are a first time user, it is recommended that you perform the operation demo in Section 3, Getting Started (paragraph 3.3) before installing any switching cards into the mainframe. This demo will acquaint you with basic front panel operation.

WARNING

The procedures in this section are intended for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

2.1 Introduction

The Model 7001 is designed to be used with the Model 701X series switch cards (i.e. Model 7011, 7012, and 7013), and with cards that were originally designed to be used with the Keithley Model 705/706 scanners.

Installation procedures in this section are organized as follows:

2.2 **Model 701X series card installation:** Explains how to install a Model 701X series card (such as the Model 7011, 7012, or 7013) card in the Model 7001.

2.3 **Non-701X series card installation:** Explains how to install cards designed for the Model 705/706 scanner in the Model 7001.

2.2 Model 701X series card installation

WARNING

Turn off power from all instrumentation (including the Model 7001 mainframe) and disconnect their line cords. Make sure all power is removed and stored energy in external circuitry is discharged.

NOTE

If using the screw terminal connector card, make sure your external circuitry is wired to the card (as explained in the instruction manual for the card) before installing the card assembly in the Model 7001 mainframe.

CAUTION

To prevent contamination to the switch card that could degrade performance, only handle the card assembly by the edges and shields. If contamination occurs, clean the card as explained in its instruction manual.

Card installation

Perform the following steps to install the card assembly in the Model 7001 mainframe:

1. Mate the connector card to the relay card if they are separate. Make sure to handle the cards by the edges and shields to prevent contamination.
2. Facing the rear panel of the Model 7001, select the slot (CARD 1 or CARD 2) that you wish to install the card in.
3. Referring to Figure 2-1 or Figure 2-2, feed the card assembly into the desired slot such that the edges of the relay card ride in the rails.
4. With the ejector arms in the unlocked position, push the card assembly into the mainframe until the arms engage into the ejector cups. Then push both arms inward to lock the card all the way into mainframe.
5. For the multi-pin connector card, install the screw shown in Figure 2-1.

NOTE

Once a Model 701X series card is installed in the mainframe, the Model 7001 automatically identifies it on power up. This ID allows the Model 7001 to configure itself for proper operation.

Card removal

To remove the card assembly, first unlock it by pulling the ejector arms outward, then pull the card assembly out of the mainframe. Remember to handle the card assembly by the edges and shields to avoid contamination that could degrade performance.

2.3 Non-701X series cards

WARNING

Turn off power from all instrumentation (including the Model 7001 mainframe) and disconnect their line cords. Make sure all power is removed and stored energy in external circuitry is discharged.

NOTE

If using a card that requires connections to be made on the card, make sure your external circuitry is wired to the card (as explained in the instruction manual for the card) before installing the card in the Model 7001 mainframe.

CAUTION

To prevent contamination to the switch card that could degrade performance, only handle the card by the edges. If contamination occurs, clean the card as explained in its instruction manual.

Card installation

Perform the following steps to install the card in the Model 7001 mainframe:

1. Facing the rear panel of the Model 7001, select the slot (CARD 1 or CARD 2) that you wish to install the card in.
2. Using Figure 2-1 or Figure 2-2 as a guideline, feed the card into the desired slot such that the edges of the card ride in the rails.
3. With the ejector arms in the unlocked position, push the card assembly into the mainframe until the arms engage into the ejector cups. Then push both arms inward to lock the card into the mainframe.

NOTE

The Model 7001 cannot automatically identify non-701X cards. After the mainframe is powered up, you must enter the model number using the TYPE menu item in the CARD CONFIG MENU (see paragraph 3.5.3 in Getting Started).

Card removal

To remove the card, first unlock it by pulling the ejector arms outward, then pull the card out of the mainframe. Remember to handle the card by the edges to avoid contamination that could degrade performance.

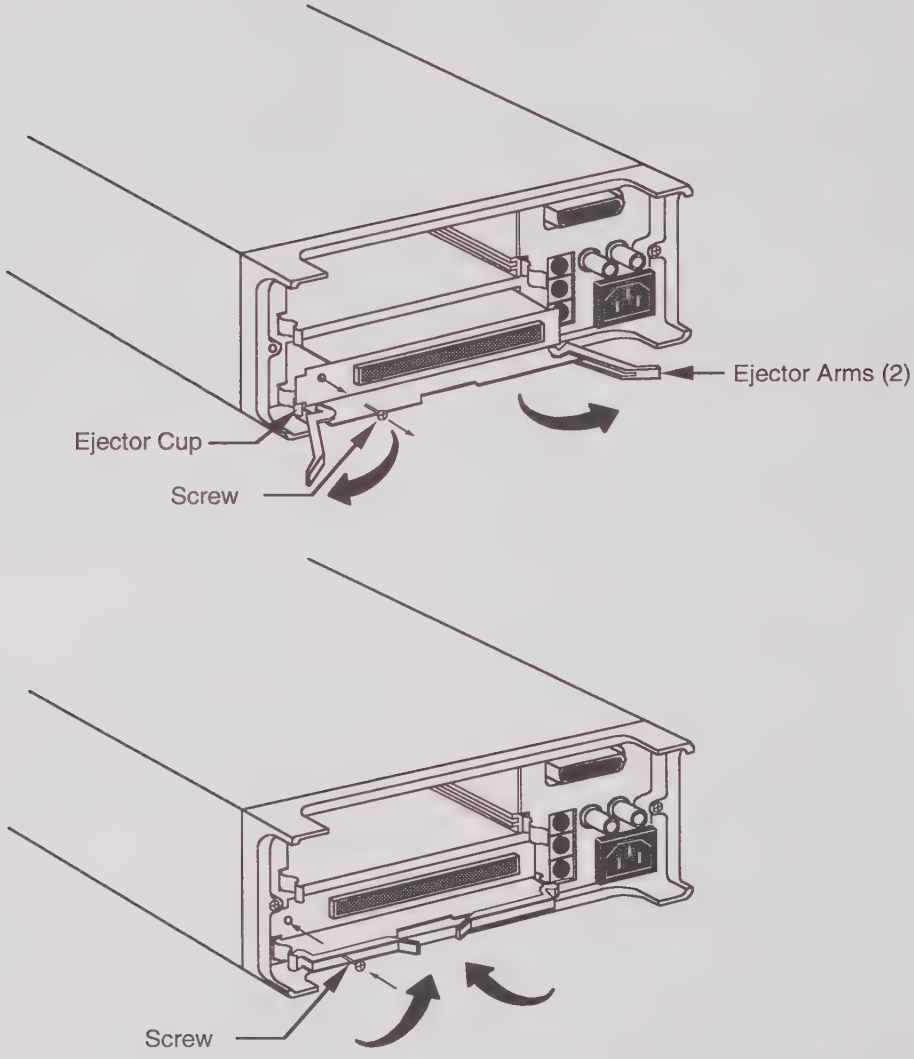


Figure 2-1
Multi-pin card installation

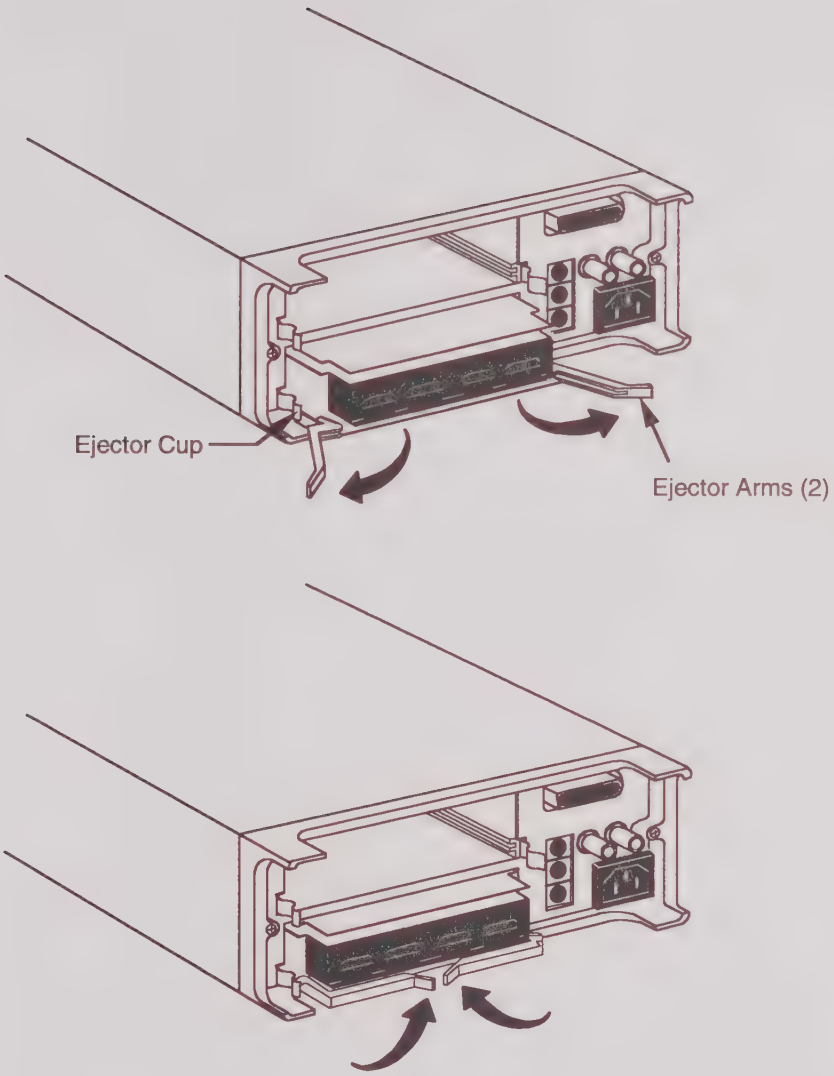


Figure 2-2
Screw terminal card installation

3

Getting Started

3.1 Introduction

This section contains introductory information on using your Model 7001 Switch System. For detailed front panel and IEEE-488 bus operation, refer to Sections 4 and 5 respectively.

The information in this section is arranged as follows:

3.2 **Front and rear panel configuration:** Summarizes the controls and display on the front panel of the instrument.

3.3 **Operation demo:** Demonstrates basic operation using the built-in 40-channel multiplexer simulator. Recommended for first time users.

3.4 **Overview of scan process:** Provides a brief overview of the scan process.

3.5 **Initial configuration:** Goes over some initial configuration information that should be considered before operating the instrument.

3.6 **Front panel operation:** Demonstrates basic front panel operation through the use of simple examples.

3.7 **Basic IEEE-488 bus operation:** Demonstrates bus operation through the use of simple examples.

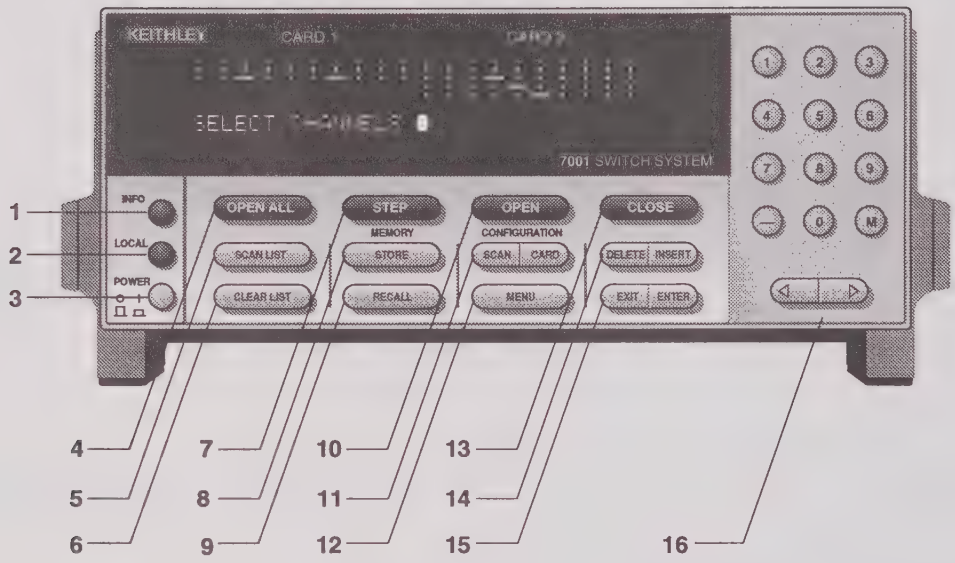
3.2 Front and rear panel configurations

3.2.1 Front panel controls

The front panel controls of the Model 7001 are shown in Figure 3-1. This figure includes important abbreviated information that should be reviewed before operating the instrument. Notice that some of the controls are dual-function, rocker-action type keys. These include SCAN/CARD CONFIGURATION, DELETE/INSERT, EXIT/ENTER and ◁ / ▷ .

3.2.2 Rear panel

The rear panel of the Model 7001 is shown in Figure 3-2. This figure also includes important abbreviated information that should be reviewed before operating the instrument.



1 INFO
Displays on-line help information. Press again (or EXIT) to cancel message.

2 LOCAL
Cancels remote, restores front panel control.

3 POWER
0 =off
1 = on

4 OPEN ALL
Opens all channels of both slots. Also, aborts a scan that is in progress and places 7001 in idle state.

5 SCAN LIST
Toggles between Scan List and Channel List

6 CLEAR LIST
Clears the displayed Channel List or Scan List.

7 STEP
Takes 7001 out of idle state and steps through Scan List

8 STORE
Stores channel pattern at a specified memory location.

9 RECALL
Restores 7001 to a channel pattern stored at a specified memory location.

10 OPEN
Opens the specified (displayed) channels in Channel List.

11 SCAN CONFIGURATION
Enables CONFIGURE SCAN MENU :
CHAN-CONTROL
SCAN-CONTROL
ARM-CONTROL
CHAN-RESTRICTIONS

CARD CONFIGURATION
Enables CARD CONFIG MENU :
TYPE
#-OF-POLES
CARD-PAIR
DELAY
READ-I/O-CARD

12 MENU
Enables MAIN MENU:
SAVESETUP
GPIB
DIGITAL-I/O
TEST
LANGUAGE
GENERAL

13 CLOSE
Closes the specified (displayed) channels in Channel List.

14 DELETE
Delete selected entry from Channel List or Scan List.

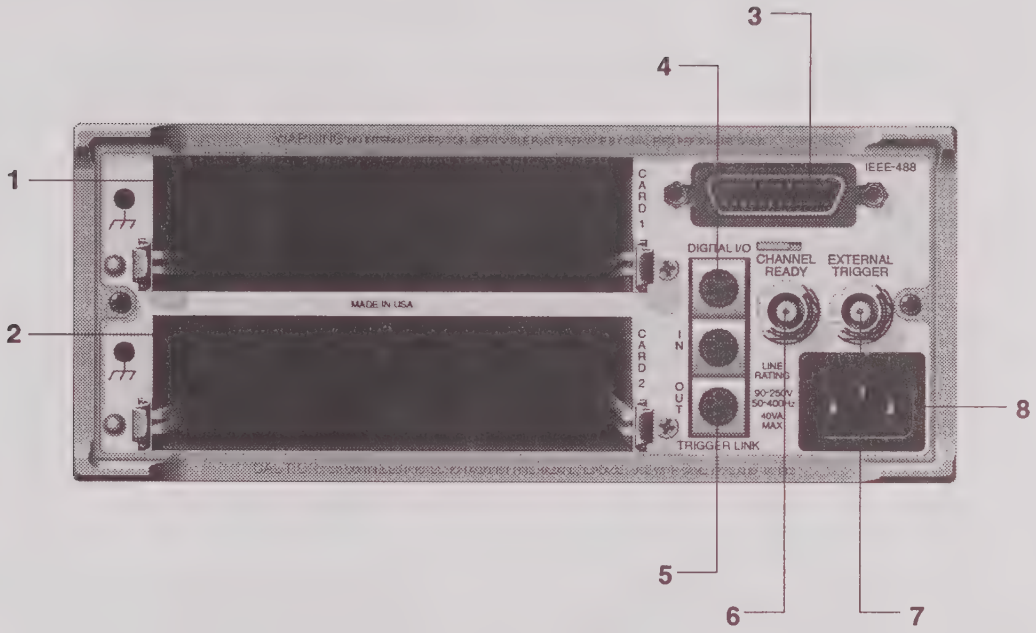
INSERT
Insert next entry at selected location in the Channel List or Scan List.

15 EXIT
Back up to previous menu selection, or exit from the menu.

ENTER
Execute the pending operation. Also, separate channels and terminate a Channel List or Scan List.

16 KEYPAD
0 - 9; use to enter numbers.
- ; use to specify a range of channels (i.e. 1!1 - 1!40).
M ; use to precede a specified memory location number.
◁; use to move cursor left or
▷; use to move cursor right. Also, use to separate channels and terminate a Channel List on Scan List.

Figure 3-1
Model 7001 front panel



1 CARD 1
Slot 1 for swich card. Corresponds to Card 1 channel status display.

2 CARD 2
Slot 2 for switch card. Corresponds to Card 2 channel status display.

3 IEEE-488 CONNECTOR
Use standard IEEE-488 cables.

4 DIGITAL I/O
Micro 8-pin DIN connector. Port consists of four TTL output lines and one TTL input line (one common line).

5 TRIGGER LINK IN AND OUT
Two micro 8-pin DIN connectors.

6 CHANNEL READY
Female BNC connector for TTL output trigger pulse.

7 EXTERNAL TRIGGER
Female BNC connector for TTL input trigger pulse.

8 LINE POWER INPUT
WARNING: Connect to grounded outlet using three-wire power cord.

Figure 3-2
Model 7001 rear panel

3.2.3 Channel status display

The channel status display provides real-time status of each available channel for the two slots. Only the available channels are displayed. There are two channel status display modes; the Channel List entry mode (SELECT CHANNEL) and the Scan List entry mode (SCAN CHANNELS). On power-up, the Channel List entry mode is selected. The SCAN LIST key toggles between the Channel List and the Scan List. The instrument can be returned to the channel status display by pressing the EXIT key one or more times.

The channel status display is shown in Figure 3-3. This display is structured as two 10-column grids. The left grid provides the channel status of the card installed in slot 1 (CARD 1) and the right grid provides the channel status of the card installed in slot 2 (CARD 2). As shown in the illustration, an open channel is represented as a "dot" while a closed channel is represented as a "dash".

Channel assignments — The channel assignment format is automatically determined by the card type. There is a three-integer format to express matrix card channels, and a two-integer format to express channels for all other types of switching cards. The individual integers that make up the channel assignment are separated by an exclamation point (!).

Matrix cards: Matrix cards use the three-integer format to express channel assignments. The first integer designates the slot number that the card is installed in. Thus, a "1" designates slot 1 (CARD 1), and a "2" designates slot 2 (CARD 2). The second integer designates the row number of the matrix card. There are four rows; the top row is Row 1, the second row from the top is Row 2, the next row is Row 3, and the bottom row is Row 4. The third integer designates the column of the matrix card. The 10 matrix columns are displayed by the channel status display. The assignments for all matrix card channels are presented in Figure 3-4.

If, for example, CARD 1 in Figure 3-3 happened to be a Model 7012 matrix card, the following channels would be closed:

Channel 1!2!3 (Slot 1, Row 2, Column 3)

Channel 1!4!9 (Slot 1, Row 4, Column 9)

All other card types: All non-matrix type switching cards use the two-integer format to express channel assignments. The first integer, like the matrix card, designates the slot number. The second integer designates switch card channel number. The channel assignments for these card types are presented in Figure 3-5.

If, for example, CARD 2 in Figure 3-3 happened to be a Model 7011 multiplexer card, the following channels would be closed:

Channel 2!14 (Slot 2, Channel 14)

Channel 2!36 (Slot 2, Channel 36)

For the Model 7011 multiplexer card, Channel 14 corresponds to Bank 1, Relay 4, and Channel 36 corresponds to Bank 3, Relay 6. See the Model 7011 instruction manual for details.

Figure 3-3
Channel status display

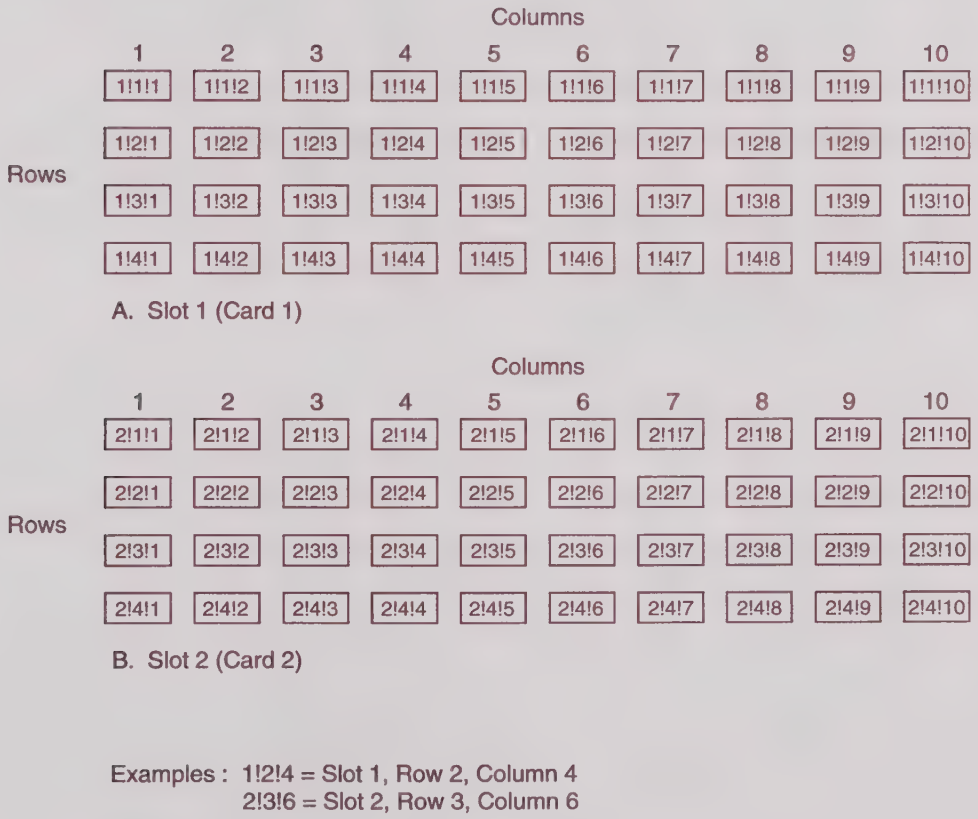
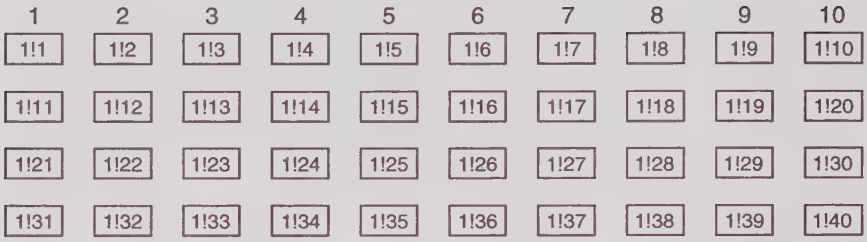


Figure 3-4
Channel assignments (matrix cards)



A. Slot 1 (Card 1)

B. Slot 2 (Card 2)

Examples : 1!18 = Slot 1, Channel 18
2!36 = Slot 2, Channel 36

Figure 3-5
Channel assignments (non-matrix type cards)

3.3 Operation demo

A fast and easy way to acquaint yourself with basic front panel operation is to use the following operation demo. This demo uses the built-in 40-channel multiplexer simulator. This will allow you to simulate operation without the need of a switching card.

3.3.1 Initial configuration

WARNING

Before turing the Model 7001 on, make sure it is connected to a grounded power receptacle using the supplied power cord or the equivalent. Failure to properly ground the unit creates a shock hazard that could result in injury or death.

Step 1 of the following procedure will RESET the Model 7001 to a default scan configuration that is required for the demonstration procedures (paragraphs 3.3.2 and 3.3.3). Step 2 will assign the 40-channel multiplexer simulator to slot 2.

Step 1. RESET instrument

1. Press the MENU key. The MAIN MENU will be displayed.
2. Place the cursor on SAVESETUP using the ◁ and ▷ cursor keys, and press the ENTER key. The SETUP MENU will be displayed.
3. Place the cursor on RESET and press ENTER. The "RESETTING INSTRUMENT" message will be displayed.
4. Press ENTER again. The "RESET COMPLETE" message will be displayed.
5. Press ENTER to return the display to the SETUP MENU.
6. Press EXIT twice to exit from the MAIN MENU.

Step 2. select multiplexer simulator

NOTE

The simulator cannot be selected if there is a Model 701X series card installed in slot 2.

1. Press the CARD CONFIGURATION key. The CARD CONFIG MENU will be displayed.
2. Place the cursor on TYPE and press ENTER. The SET CARD TYPE menu will be displayed.
3. Place the cursor on SLOT-2 and press ENTER. The "SLOT-2 CARD: XXXX" message will be displayed (where XXXX is the current card assignment for slot 2).
4. Use the cursor keys to display model number "9990".
5. With "SLOT-2 CARD: 9990" displayed, press ENTER. The SET CARD TYPE menu will be displayed.
6. Press EXIT twice to exit from the CARD CONFIG MENU.

3.3.2 Close and open channels

The following procedures assume that the initial configuration procedure in paragraph 3.3.1 has been performed. This initialization will assign the 40-channel multiplexer simulator to Slot 2 for the following operating examples.

NOTE

The Model 7001 must be in the Channel List display mode ("SELECT CHANNELS" prompt displayed). The SCAN LIST key toggles the channel status display between "SELECT CHANNELS" (Channel List) and "SCAN CHANNELS" (Scan List). If the instrument is not in the channel status display mode, press EXIT until it is.

Create Channel List:

The Channel List specifies which channels you wish to close and open. The Channel List can be made up of a single channel, or multiple channels. Consecutive channels can be specified as a range.

The following procedure will create a Channel List that includes Channels 1, 2, and 6 through 9:

1. If the Channel List is not currently empty, press CLEAR LIST. The following message indicates an empty Channel List:

   SELECT CHANNELS

2. Individual Channel Entry - Perform the following steps to enter Channels 1 and 2 in the Channel List:
   A. Press "2" and then "1" to enter Channel 1 into the Channel List. The "2" selects slot 2.

      SELECT CHANNELS 2!1

   B. Press ▷ or ENTER to enter the channel separator (,).

      SELECT CHANNELS 2!1,

   C. Press "2" and then "2" to enter channel 2, and then press ▷ or ENTER to enter the channel separator (,).

      SELECT CHANNELS 2!1, 2!2,

3. Range Entry - Perform the following steps to enter Channels 6 through 9 as a range:
   A. Press "2" and then "6" to enter the range limit (Channel 6).

      SELECT CHANNELS 2!1, 2!2, 2!6

   B. Press "-" to enter the range separator. Note that the slot number for the next channel is automatically entered.

      SELECT CHANNELS 2!1, 2!2, 2!6-2!

   C. Press "9" to enter the range limit.

      SELECT CHANNELS 2!1, 2!2, 2!6-2!9

Close and open channels

1. Press CLOSE to close the channels specified in the Channel List.
2. Press OPEN to open the channels specified in the Channel List. Note that OPEN ALL opens all channels (even those not specified in the Channel List).

3.3.3 Scan channels

The following procedures assume that the initial configuration procedure in paragraph 3.3.1 has been performed. This initialization will assign the 40-channel multiplexer simulator to Slot 2 for the following scan examples.

NOTE

The Model 7001 must be in the Scan List display mode ("SCAN CHANNELS" prompt displayed). The SCAN LIST key toggles the channel status display between "SELECT CHANNELS" (Channel List) and "SCAN CHANNELS" (Scan List). If the instrument is not in the channel status display mode, press EXIT until it is.

Create scan list

Perform the following steps to create a scan list that will scan channels 1 through 20:

1. If the Scan List is not currently empty, press CLEAR LIST. The following message indicates an empty Scan List:

   SCAN CHANNELS

2. Press "2" and then "1" to enter the slot and the range limit.

   SCAN CHANNELS 2!1

3. Press "-" to enter the separator for the range limits. Notice that the slot number for the next channel will automatically be entered.

   SCAN CHANNELS 2!1-2!

4. Press "2" and then "0" to enter the limit of the range.

```
SCAN CHANNELS 2!1-2!20
```

5. Press ▷ or ENTER to enter the scan list terminator (,).

```
SCAN CHANNELS 2!1-2!20,
```

Note: Instead of specifying the 20 channels in the scan list as a range, they could have been entered individually (2!1, 2!2, 2!3, ... 2!20,).

Manual scan

The RESET defaults configure the instrument to manually scan an infinite number of channels. After the 20th channel is scanned, operation will wrap around to the beginning of the scan list (Channel 1).

1. Press STEP to take the Model 7001 out of the idle state. The ARM indicator will turn on.
2. Press the STEP key to scan the first channel. This channel will remain closed until another channel is scanned.
3. Press the STEP key to scan the second channel. The first channel will open and the second channel will close.
4. Each press of the STEP key will open the previous channel and close the next channel (break-before-make).
5. When finished, press OPEN ALL to abort the scan and open all channels. The instrument goes into the idle state (ARM indicator turns off).

Automatic scan

Perform the following steps to automate the 20-channel scan. A 0.5 second delay will be used between each channel.

1. Press OPEN ALL if there are any channels closed or the ARM indicator is on
2. Press the SCAN CONFIGURATION key. The CONFIGURE SCAN menu will be displayed.

NOTE

Due to space limitations, not all menu selections can be displayed on the Model 7001 at the same time. A displayed arrow (◀ or ▶) indicates that there are additional menu selections to choose from. Use the ◁ and ▷ cursor keys to display them.

3. Using the ◁ and ▷ keys, place the cursor on CHAN-CONTROL and press ENTER. The CHANNEL CONTROL menu will be displayed.
4. Place the cursor on CHANNEL-SPACING and press ENTER. The SELECT CHAN SPACING menu will be displayed.

```
SELECT CHAN SPACING
TRIGLINK      IMMEDIATE      HOLD
```

5. Place the cursor on IMMEDIATE and press ENTER. The display will return to the CHANNEL CONTROL menu.
6. Press EXIT twice to exit from the CONFIGURE SCAN menu and return to the channel status display.
7. Press CARD CONFIGURATION. The CARD CONFIG MENU will be displayed.

```
CARD CONFIG MENU
DELAY          READ-I/O-CARD
```

8. Place the cursor on DELAY and press ENTER. The SET DELAY FOR: menu will be displayed.
9. Place the cursor on SLOT-2 and press ENTER. The delay period (in seconds) will be displayed.

```
(2)DELAY = 00000.000
```

10. Use the keypad to set the delay for 0.5 seconds.

```
(2)DELAY = 00000.500
```

This delay will occur after each channel closes.

11. Press ENTER. The display will return to the SET DELAY FOR: menu.
12. Press EXIT twice to return to the channel status display.

13. To start the scan, simply press STEP. The instrument leaves the idle state (ARM indicator on) and immediately closes the first channel. After a 0.5 second delay the first channel will open and the second channel will close. This automatic scan will continue at the 0.5 second scan rate.
14. When finished, press OPEN ALL.

TIMER controlled scans

An internal timer can be used to control the time interval between the scans. The 20-channel scan will be modified by using a TIMER to place a 20-second interval between the start of each scan.

1. Press OPEN ALL to ensure that the instrument is in the idle state.
2. Press SCAN CONFIGURATION. The CONFIGURE SCAN menu will be displayed.
3. Place the cursor on SCAN-CONTROL and press ENTER. The SCAN CONTROL menu will be displayed.
4. Place the cursor on SCAN-SPACING and press ENTER. The SELECT SCAN SPACING menu will be displayed.

```
SELECT SCAN SPACING
TIMER    EXTERNAL    GPIB    MANUAL
```

5. Place the cursor on TIMER and press ENTER. The timer interval (in seconds) will be displayed.

```
INTERVAL = 00000.001
```

6. Use the keypad to key in an interval of 20 seconds.

```
INTERVAL = 00020.000
```

7. Press ENTER. The display will return to the SCAN CONTROL menu.
8. Press EXIT twice to exit from the CONFIGURE SCAN menu and return to the channel status display.
9. To start the scan, press STEP. The first scan will start immediately and stop after the 20th channel closes. After 10 additional seconds expires (20 seconds after the start of the scan), the next scan will start.
10. When finished, press OPEN ALL.

3.4 Overview of scan process

The following overview is intended to acquaint you with the basic scan fundamentals without overwhelming you with the details of enhanced capabilities. This brief overview is sufficient to support the operation examples in paragraphs 3.5 (front panel) and 3.6 (IEEE-488 bus). For a complete explanation on all aspects of the scan process, see paragraph 4.5.4.

The simplified model for scan operation is shown in Figure 3-6. As shown, scan operation consists of three layers; the arm layer, scan layer and channel layer.

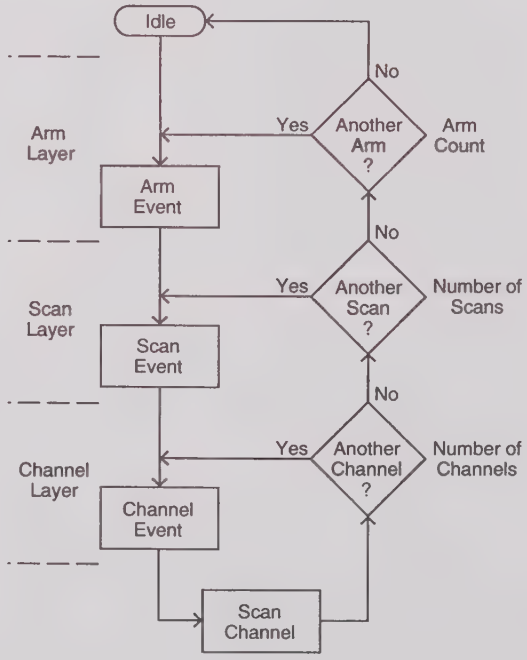


Figure 3-6
Simplified model of scan operation

Idle

The instrument is considered to be in the idle state whenever it is not operating within one of the layers of the model. The front panel ARM indicator is off when the instrument is in the idle state.

When the Model 7001 is taken out of the idle state by pressing STEP (or sending the :INIT or :INIT:CONT ON command over the IEEE-488 bus), the ARM indicator turns on and operation proceeds into the arm layer.

Arm layer

In general, the instrument requires an arm event to allow operation to proceed to the scan layer. With Immediate arm spacing selected, operation immediately proceeds to the next layer when the instrument is taken out of the idle state. With one of the other arm spacing events selected, the instrument will wait until the appropriate event occurs.

With Manual arm spacing selected, the instrument will wait until the front panel STEP key is pressed. With GPIB arm spacing selected, the instrument will wait until a bus trigger (GET or *TRG) is received. With External arm spacing selected, the instrument will wait until an input trigger (via EXTERNAL TRIGGER connector on rear panel) is received. With Trigger Link arm spacing selected, the instrument will wait until an input trigger is received (via TRIGGER LINK).

After all other scanning operations are completed, the instrument can be returned to the arm layer by programming the instrument for additional arms. The arm count can be set to a finite value (1 to 9999) or to infinity.

After the instrument leaves the arm layer, operation proceeds into the scan layer.

Scan layer

In general, the instrument requires a scan event to allow operation to proceed to the channel layer. With Immediate scan spacing selected, operation immediately proceeds to the next layer. With one of the trigger scan spacing events selected (Timer, External, GPIB, Manual, Trigger Link), the instrument will wait until the appropriate event occurs. With Timer scan spacing selected, the first pass through the scan layer will occur immediately. If programmed for additional scans, the instrument will wait until the Timer times out. The Timer can be set for an interval from 1msec to 99999.999 seconds.

The scan count (number of scans) can be set to a finite value (1 to 9999) or for an infinite number of scans.

After the instrument leaves the scan layer, operation proceeds into the channel layer.

Channel layer

In general, channel events control the channel scan rate. With Immediate channel spacing selected, a channel will be scanned immediately. With one of the other channel spacing events selected (Timer, External, GPIB, Manual or Trigger Link), the instrument will wait until the appropriate event occurs before scanning a channel. With Timer channel spacing selected, the first channel will be scanned immediately. Each additional channel will wait for the Timer to time out before it will be scanned.

Typically, the channel count (number of channels to scan) is set to the number of channels that are contained in the Scan List (scan-list-length). However, the channel count can be set to a finite value (1 to 9999) or to infinity.

3.5 Initial configuration

WARNING

Before turning the Model 7001 on, make sure it is connected to a grounded power receptacle using the supplied power cord or the equivalent. Failure to properly ground the unit creates a shock hazard that could result in injury or death.

Before performing any basic operations (close/open channels or scan channels) there are a few initial configurations that must first be considered. If you are using Model 701X series cards (i.e. Model 7011, 7012 and 7013), and they are already installed in the mainframe (as explained in Section 2), skip the following configuration information and proceed to paragraphs 3.5 (front panel operation) and 3.6 (IEEE-488 bus operation).

3.5.1 Switching card simulators

Instrument operation can be performed without any switching cards installed in the Model 7001 by using the switching card simulators. By selecting the appropriate switching card simulator, the Model 7001 will operate as if a 40-channel switching card or a 4 × 10 matrix card were installed. This is useful if you want to develop a test program without having a card installed.

When a slot is assigned the model number 9990, the mainframe will operate as if a 40-channel switching card is installed. When a slot is assigned model number 9991, the mainframe will operate as if a 4 × 10 matrix card is installed. These simulator model numbers are assigned by setting card TYPE in the CARD CONFIG MENU (see paragraph 3.5.3). If you are going to use the simulators to perform the operating examples in paragraph 3.6, configure Slot 1 for non-matrix switching (model 9990), and Slot 2 for matrix switching (model 9991).

NOTE

A simulator cannot be assigned to a slot that already has a Model 701X series card installed in it. To use a simulator, turn off the Model 7001 and remove the card from the slot.

3.5.2 Installing switching cards

The procedure to install switching cards in the mainframe is explained in Section 2 of this manual. If using switching card simulators as explained in the previous paragraph, leave the slots empty.

3.5.3 Card type

In order for the Model 7001 to operate properly, it must know what type of card is installed in each of its two slots. If a Model 701X series card (such as the Model 7011, 7012 or 7013) is installed in a slot, the mainframe automatically identifies the card type on power-up and configures its operation appropriately. With Model 701X series cards installed in the mainframe, you can disregard the procedure in this paragraph and proceed on to basic front panel operation (paragraph 3.5).

For other card types (non-701X series cards) and simulators, the user must assign the proper model number to the slot. Once a model number is assigned by the user, it will be remembered on subsequent power-ups as long as a Model 701X series card is not installed. Note that a slot can also be designated as empty. With this assignment, the front panel status display for that slot will be disabled.

Perform the following procedure to assign a model number (or designate it as empty) to one or both of the mainframe slots:

1. Turn on the Model 7001. During the power-up sequence, the instrument will briefly display which Model 701X series cards are currently installed, or the last slot assignments.

   Example — If a Model 7013 card is installed in slot 1, and slot 2 was last designated to be empty, the following message will be displayed briefly during the power-up sequence:

   #1 = 7013 #2 = NONE

   If slot 2 is empty and you do not wish to assign it a simulator, stop here and proceed to basic front panel operation (paragraph 3.5). If slot 2 has a non-701X series card (i.e. Model 7156) installed in it, continue with this procedure to assign the appropriate model number to the slot.

2. Press CARD CONFIGURATION to enable the following menu:

   CARD CONFIG MENU
   TYPE #-OF-POLES CARD-PAIR ▶
   ◀ DELAY READ-I/O-CARD

NOTE

A displayed arrow (◀ or ▶) indicates that more menu selections are available. Use the cursor keys (◁ and ▷) to display them.

3. Using the ◁ and ▷ cursor keys, place the cursor (flashing menu item) on TYPE and press ENTER. The following menu will be displayed:

```
SET CARD TYPE
SLOT-1    SLOT-2
```

4. Place the cursor on the slot that needs to be assigned and press ENTER. For example, if you selected Slot 1, the following typical message will be displayed:

```
SLOT-1 CARD: NONE
```

The above message indicates that there is not a Model 701X series card installed in slot 1, and slot 1 was last designated as an empty slot.

5. Perform one of the following steps:
   A. Empty Slot — If you want to assign the slot as empty, use the cursor keys (◁ and ▷) to display the "NONE" message. Example:

```
SLOT-1 CARD: NONE
```

The above message indicates that, when ENTERed (Step 6), slot 1 will be configured to operate as an empty slot.

   B. Simulator — If you want the slot to simulate a 40- channel switching card, use the cursor keys (◁ and ▷) to display model number 9990. If you want the slot to simulate a 4 × 10 matrix card, use the cursor keys to display model number 9991. Example:

```
SLOT-1 CARD: 9990
```

The above message indicates that, when ENTERed (Step 6), slot 1 will be configured to operate as a 40-channel switching card.

   C. Non-701X Series Card — To assign the slot to the non-701X series card, use the cursor keys (◁ and ▷) to display the model number of that card. For example, if a Model 7156 is installed in slot 1, use the cursor keys to display the following message:

```
SLOT-1 CARD: 7156
```

The above message indicates that, when ENTERed (Step 6), slot 1 will operate properly with a Model 7156 installed in it.

6. With the appropriate slot assignment message displayed, press ENTER to execute the assignment. The display will return to the SET CARD TYPE menu.
7. To assign the other slot, repeat steps 4 through 6.
8. To exit from the CARD CONFIG MENU, press EXIT twice.

NOTE

The EXIT key can be used anywhere in the CARD CONFIG MENU structure. Each press of the EXIT key will back up the display to the previous menu level without executing a pending operation.

3.6 Front panel operation

Basic front panel operation will be demonstrated through the use of examples. One example demonstrates close/open operation and the other example demonstrates scanning. These examples are only intended to teach basic operation. Complete details for using the full capabilities of the Model 7001 from the front panel are contained in Section 4 of this manual.

NOTE

Operation examples assume that the Model 7001 is initially configured for proper operation as explained in paragraph 3.5.

3.6.1 Close/open operation example

One of the basic functions of the Model 7001 is to simply close and open one or more specified channels. The following example will demonstrate this operation.

The example can be performed if you have a non-matrix switching card installed and/or a matrix card installed. If using the card simulators, configure slot 1 for non-matrix switching (model 9990) and slot 2 for matrix switching (model 9991) as explained in paragraph 3.5.3.

Channels that are controlled in this example include:

Switching Card Channels: 1, 3, 4, 5 and 6.

Matrix Card Channels: Row 1 Column 1, Row 2 Column 2, Row 2 Column 3, Row 2 Column 4, Row 2 Column 5 and Row 2 Column 6

Perform the following steps to close/open channels of a non-matrix switching card and/or a matrix card.

Step 1. Place instrument in Channel List display state.

If not already in the channel status display state, press EXIT one or more times. Once in the channel status display state, the SCAN KEY will toggle between the Channel List (SELECT CHANNELS) and the Scan List (SCAN CHANNELS).

SELECT CHANNELS

If there is Channel List currently displayed, press CLEAR LIST to cancel it. Also, if there are any channels currently closed, press OPEN ALL to open them.

Step 2. Enter Channel List.

Switching Card — For a non-matrix switching card, enter the Channel List (Channels 1, 3, 4, 5 and 6) for slot 1 as follows:

NOTE

The following procedure assumes that slot 1 is configured for non-matrix switching. If using slot 2 for non-matrix switching, modify (A) of steps 1 and 2 by pressing "2" instead of "1".

1. Enter first channel (Channel 1) using the single channel entry method:
   - A. Press "1" — Enters slot
   - B. Press "1" — Enters channel
   - C. Press "▷ " or "ENTER" — Enters channel separator (comma)

SELECT CHANNELS 1!1,

2. Enter the rest of the channels (Channels 3 through 6) using the channel range entry method:
   - A. Press "1" — Enters slot
   - B. Press "3" — Enters first channel
   - C. Press "-" — Enters range designator and slot
   - D. Press "6" — Enters last channel
   - E. Press "▷ " or "ENTER" — Enters channel list terminator (comma)

SELECT CHANNELS 1!1, 1!3-1!6,

Note: Channels 3, 4, 5, and 6 could have been entered using the single channel entry method demonstrated in step 1.

Matrix card — For a matrix card, enter the Channel List (Row 1 Column 1,Row 2 Column 2, Row 2 Column 3, Row 2 Column 4, and Row 2 Column 5 for slot 2) as follows:

Note: The following procedure assumes that Slot 2 is configured for a matrix. If using slot 1 for a matrix, modify (A) of steps 1 and 2 by pressing "1" instead of "2" to enter the slot.

1. Enter first channel (Row 1 Column 1) using the single channel entry method:
   - A. Press "2" — Enters slot
   - B. Press "1" — Enters row
   - C. Press "1" — Enters column
   - D. Press "▷ " or "ENTER" — Enters channel separator (comma)

SELECT CHANNELS 2!1!1,

2. Enter the rest of the channels (Row 2 Column 2 through Row 2 Column 5) using the channel range entry method:

A.	Press "2"	Enters slot
B.	Press "2"	Enters row of first channel
C.	Press "2"	Enters column of first channel
D.	Press "-"	Enters range designator
E.	Press "2"	Enters row of last channel
F.	Press "5"	Enters column of last channel
G.	Press "▷ " or "ENTER"	Enters channel list terminator (comma)

SELECT CHANNELS 2!1!1, 2!2!2-2!2!5,

Note: The single channel entry method demonstrated in step 1 could have been used to enter the channels for row 2.

Step 3. Close (or open) listed channels.

1. To close the channels specified in the channel list, simply press CLOSE. The closed channels will be indicated on the channel status display.
2. To open the closed channels that are specified in the channel list, press OPEN. Note that only channels specified in the list are opened. Unspecified channels (as well as channels in the channel list) are opened by pressing OPEN ALL.

Closing additional channels

After you have closed the channels in channel list, you may want to close one or more additional channels. Closing an additional channel is simply a matter of entering the channel in the channel list and pressing "CLOSE". For example, assume your channel list looks like this:

SELECT CHANNELS 1!1, 1!3-1!6,

To close channel 1!8, position the cursor at the end of the channel list and press "1", "8" and then CLOSE. The channel list will now look like this:

SELECT CHANNELS 1!1, 1!3-1!6, 1!8,

You could also have closed the additional channel by first clearing the channel list (pressing CLEAR LIST), and then entering and closing the channel. However, keep in mind that once you clear a channel list, it cannot be recalled. You will have to re-enter the entire list.

Opening closed channels

As previously explained, pressing OPEN will open all the channels specified in the channel list. If you want to open one or more, but not all channels, you will have to clear the channel list by pressing CLEAR LIST, and then enter a new channel list that specifies the closed channels you wish to open. Once the new channel list is entered, simply press OPEN to open those channels.

3.6.2 Scan operation example

The Model 7001 can scan through a list of specified channels. The order of the channels in the Scan List determines the channel order for the scan. The following example will demonstrate this operation.

The example can be performed if you have a non-matrix switching card installed and/or a matrix card installed. If using the card simulators, configure slot 1 for non-matrix switching (model 9990), and slot 2 for matrix switching (model 9991) as explained in paragraph 3.4.3.

Channels that are scanned in this example include:

Switching Card Channels: 1, 3, 4, 5, and 6.

Matrix Card Channels: Row 1 Column 1, Row 2 Column 2, Row 2 Column 3, Row 2 Column 4, Row 2 Column 5 and Row 2 Column 6.

Perform the following steps to scan channels of a non-matrix switching card and/or a matrix card. Three scans of the specified Scan List will be performed.

Step 1. RESET the Model 7001.

By performing RESET, the Model 7001 will set itself to default conditions that are typically used to control a scan.

1. Press the MENU key. The following menu will be displayed:

```
MAIN MENU
SAVESETUP     GPIB          DIGITAL-I/O ▶
◀ TEST        LANGUAGE      GENERAL
```

2. Use the cursor keys (◁ and ▷) to place the cursor (flashing menu item) on SAVESETUP and press the ENTER key. The following menu will be displayed:

```
SETUP MENU
SAVE    RESTORE    PWRON    RESET
```

3. Place the cursor on RESET and press ENTER. The following message will be displayed;

```
RESETTING INSTRUMENT
```

4. Press ENTER. The following message will be displayed:

```
RESET COMPLETE
```

5. Again press ENTER to return to the SETUP MENU.
6. Press EXIT twice to exit from the menu structure.

Step 2. Place instrument in Scan List display state.

With the instrument in the Channel List display state, press SCAN LIST to select the Scan List entry display state. The following message prompt will be displayed:

```
SCAN CHANNELS
```

If there is a scan list currently displayed, press CLEAR LIST to cancel it. Also, if there are any channels currently closed, press OPEN ALL to open them.

Step 3. Enter Scan List.

Switching Card — For a non-matrix switching card, enter the scan list (Channels 1, 3, 4, 5, and 6) for slot 1 as follows:

Note: The following procedure assumes that slot 1 is configured for non-matrix switching. If using slot 2 for non-matrix switching, modify (A) of steps 1 and 2 by pressing "2" instead of "1".

1. Enter first channel (Channel 1) using the single channel entry method:
   A. Press "1" — Enters slot
   B. Press "1" — Enters channel
   C. Press "▷ " or "ENTER" — Enters channel separator (comma)

```
SCAN CHANNELS 1!1,
```

2. Enter the rest of the channels (Channels 3 through 6) using the channel range entry method:
   A. Press "1" — Enters slot
   B. Press "3" — Enters first channel
   C. Press "-" — Enters range designator and slot
   D. Press "6" — Enters last channel
   E. Press "▷ " or "ENTER" — Enters channel list terminator (comma)

```
SCAN CHANNELS 1!1, 1!3-1!6,
```

Note: Channels 3, 4, 5 and 6 could have been entered using the single channel entry method demonstrated in step 1.

Matrix Card — For a matrix card, enter the scan list (Row 1 Column 1, Row 2 Column 2, Row 2 Column 3, Row 2 Column 4, and Row 2 Column 5 for slot 2) as follows:

Note: The following procedure assumes that slot 2 is configured for a matrix. If using slot 1 for a matrix, modify (A) of steps 1 and 2 by pressing "1" instead of "2".

1. Enter first channel (Row 1 Column 1) using the single channel entry method:
   A. Press "2" — Enters slot
   B. Press "1" — Enters row
   C. Press "1" — Enters column
   D. Press "▷ " or "ENTER" — Enters channel separator (comma)

```
SCAN CHANNELS 2!1!1,
```

2. Enter the rest of the channels (Row 2 Column 2 through Row 2 Column 5)using the channel range entry method:
   A. Press "2" — Enters slot
   B. Press "2" — Enters row of first channel

C.	Press "2"	Enters column of first channel
D.	Press "-"	Enters range designator and slot
E.	Press "2"	Enters row of last channel
F.	Press "5"	Enters column of last channel
G.	Press "▷" or "ENTER"	Enters channel list terminator (comma)

SCAN CHANNELS 2!1!1, 2!2!2-2!2!5,

Note: The single channel entry method demonstrated in step 1 could have been used to enter the channels for row 2.

Step 4. Configure channel layer of scan.

NOTE

When RESET was performed (Step 1), the channel layer was reset to MANUAL channel scanning. In MANUAL, the first press of STEP will take the instrument out of the idle state and each subsequent press will manually step through the scan. Go ahead and try it. When finished, press OPEN ALL to place the Model 7001 in the idle state.

For this example, the channel scan rate will be controlled by the timer. In general, every time the timer times out, the next channel in the scan will be selected.

Since the Model 7001 was RESET, only CHANNEL SPACING needs to be programmed.

Configure the channel layer as follows:

1. Press SCAN CONFIGURATION to display the following menu:

   CONFIGURE SCAN
   CHAN-CONTROL SCAN-CONTROL ▶
   ◀ ARM-CONTROL CHAN-RESTRICTIONS

2. Using the cursor keys (◁ and ▷), place the cursor on CHAN-CONTROL (Channel Layer) and press ENTER. The following menu will be displayed:

   CHANNEL CONTROL
   CHANNEL-SPACING NUMBER-OF-CHANS ▶
   ◀ CONTROL

3. Place the cursor on CHAN-SPACING and press ENTER. The following menu will be displayed:

   SELECT CHAN SPACING
   TIMER EXTERNAL GPIB MANUAL ▶
   ◀ TRIGLINK IMMEDIATE HOLD

4. Place the cursor on TIMER and press ENTER. The current timer interval (in seconds) will be displayed:

   INTERVAL = 00000.001

   The above message indicates that the timer is currently set for 1msec.

5. Set the timer for a half second interval by using the cursor keys and number keys. The timer interval should look like this:

   INTERVAL = 00000.500

6. Press ENTER to select the timer as the event that controls the channel scan. The display returns to the following menu:

   CHANNEL CONTROL
   CHANNEL-SPACING NUMBER-OF-CHANS ▶
   ◀ CONTROL

   Note: When the Model 7001 was RESET, the number of channels to scan was set to the scan list length, which is what you want for this example.

7. Press EXIT to return the display to the CONFIGURE SCAN menu.

Step 5. Configure scan layer of scan.

When the Model 7001 was RESET (Step 1), the scan layer was reset to IMMEDIATE scan spacing, which is appropriate for this example. This means each programmed scan will occur immediately and not wait for an event to occur.

Also, the scan layer was RESET to perform an infinite number of scans. Since this example requires only three scans, change the NUMBER OF SCANS as follows:

1. The Model 7001 should be displaying the following menu:

   CONFIGURE SCAN
   CHAN-CONTROL SCAN-CONTROL ▶
   ◀ ARM-CONTROL CHAN-RESTRICTIONS

2. Place the cursor on SCAN-CONTROL and press ENTER. The following menu will be displayed:

   SCAN CONTROL
   SCAN-SPACING NUMBER-OF-SCANS ▶
   ◀ CONTROL

3. Place the cursor on NUMBER-OF-SCANS and press ENTER. The following menu will be displayed:

   NUMBER OF SCANS
   INFINITE ENTER-SCAN-COUNT

4. Place the cursor on ENTER-SCAN-COUNT and press ENTER. The following typical message indicating the scan count will be displayed:

   SCAN COUNT = 0000

   A scan count of zero indicates that the scan layer is currently configured for an infinite number of scans.

5. Key in a scan count of 3.

   SCAN COUNT = 0003

6. To configure the instrument for three scans, press ENTER. The display will return to the SCAN CONTROL menu.
7. Press EXIT twice to exit from the menu structure.

Note: RESET (Step 1) configured the arm layer for IMMEDIATE arming, and for an arm count of one. Both of these arm conditions are appropriate for this example. Thus, arm layer configuration is not necessary.

Step 6. Perform the scan.

To perform the scan, simply press the STEP key. On the display, the scan will arm (ARM indicator will turn on), and the mainframe will scan through the channels of the scan list three times. At the conclusion of the third scan, the Model 7001 will return to the idle state (ARM indicator will turn off). Note however that the last channel in the scan list remains closed.

NOTE

The last channel in the scan remains closed. If your test requires that the last channel open after the scan, proceed to the next step.

Step 7. Open the last channel

To have the last channel open at the conclusion of the third scan, you will need to assign a blank channel pattern (all channels open) from memory as the last channel entry in the Scan List.

To save a blank channel pattern in memory, perform the following steps:

1. Display the Channel List (SELECT CHANNELS) and press OPEN ALL to open all channels.
2. Press STORE. The following typical message will be displayed:

   STORE CHANS AT #001

3. To store the blank channel pattern in memory location 1, press ENTER. Note that the blank channel pattern could have been stored at any one of the 100 memory locations (1 to 100) by keying in the desired value and then pressing ENTER.

With a blank channel pattern stored at memory location 1 (M1), add it to your Scan List as follows:

1. Display the scan list (press SCAN LIST if necessary).
2. Use the ▷ cursor key to position the cursor at the end of the scan list.
3. Enter the blank channel pattern by pressing "M", "1" and then ▷ or ENTER to terminate the Scan List.

SCAN CHANNELS 1!1, 1!3-1!6, 2!1!1, 2!2!2-2!2!5, M1,

Repeat the scans by again pressing STEP. At the conclusion of the third scan, the last channel (Channel 2!2!5, if using the scan list above), will open.

3.7 IEEE-488.2 and SCPI basics

The following paragraphs discuss fundamental information concerning operation over the IEEE-488 bus. Detailed information on operating the instrument from over the bus is contained in Section 5 of this manual.

SCPI overview

IEEE-488.2 defines a syntax for sending data to and from instruments. It also defines a set of Common Commands that are used to perform basic operations such as reading status registers, providing triggers and resetting the instrument to default conditions.

SCPI (Standard Commands for Programmable Instruments) defines a standard set of commands (and format) to control every other aspect of instrument operation. Together, IEEE-488.2 and SCPI create a command structure for all programmable instruments.

Compatibility

An instrument that uses the IEEE-488.2 standard and SCPI does not have any special hardware requirements. The IEEE-488 interface that you used with the old standard will work with the new standard. Simply connect the Model 7001 to a computer that is equipped with an IEEE-488 interface.

NOTE

The term GPIB (General Purpose Interface Bus) is used in this manual and in the menu structure of the instrument. GPIB is simply another term for the IEEE-488 bus.

3.7.1 Bus connections

Before using the instrument over the bus, you must connect the IEEE-488 connector on the rear panel of the instrument to the IEEE-488 connector of your controller. Use a Keithley Model 7007 or similar IEEE-488 cable for this connection.

3.7.2 Primary address

The primary address of the Model 7001 must agree with the primary address you intend to specify in the controller's programming language. The factory setting for the primary address is 7, so if you intend to use that address, you need not change it. However, the primary address can be set to any value between 0 and 30 by using the GPIB setup menu (ADDRESS selection) available with the MENU key.

3.7.3 Abbreviated common command summary

Table 3-1 provides an abbreviated list of Common Commands which are defined by the IEEE-488.2 standard. These are the Common Commands that are most used for bus operation. Note that each Common Command is preceded by a star (*).

3.7.4 Abbreviated SCPI command summary

Most instrument operations are controlled using SCPI commands. Table 3-2 provides an abbreviated list of the SCPI commands necessary to perform some basic operations.

Not shown in the table are companion query commands for the :ARM and :TRIGger Subsystem commands (:COUNt?, :DELay?, :SOURce?, and :TIMer?). For example, the :TRIGger:SOURce? query command is used to request the currently selected control source. After the query command is sent and the Model 7001 is addressed to talk, a message identifying the selected control source will be sent to the computer.

Table 3-1
Abbreviated common command summary

Mnemonic	Name	Description
*CLS	Clear status	Clears Error Queue and event registers.
*RST	Reset	Returns the 7001 to *RST default conditions (see Table 5-6).
*TRG	Trigger	Issues a bus trigger (same as group execute trigger command; GET).
*SAV <n>	Save	Saves the current setup configuration in memory (n = 0 to 9).
*RCL <n>	Recall	Returns the instrument to the setup configuration stored in memory (n = 0 to 9).

Table 3-2
Abbreviated SCPI command summary

:SYSTem	Subsystem command path.
:PRESet	Set scan to a default configuration (see Table 5-6)
[:ROUTe]	Subsystem command path.
:CLOSe <list>	Path and command to close specified channels:
:STATe?	Request channels that are closed.
:OPEN <list> | ALL	Open specified (or all) channels.
:SCAN <list>	Path and command to specify channel list:
:INITiate	Initiate one trigger (scan) cycle.
:ABORt	Reset trigger system and goes to idle state.
:ARM	Subsystem command path to configure scan:
:LAYer2	Path to program scan layer:
:COUNt <n> | INF	Program number of scans (1 to 9999, or INFinite).
:DELay <num>	Program delay (0 to 99999.999 seconds
:SOURce HOLD | IMMediate | TIMer | MANual | BUS | TLINk | EXTernal	Select event to control scan spacing.
:TIMer <num>	Set timer interval (0.001 to 99999.999 sec).
:TRIGger	Subsystem command path to program channel layer:
:COUNt <n> | INF	Program number of channels (1 to 9999, or INFinite).
:AUTo ON/OFF	Enable/disable automatic scan list count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer	Select event to control channel spacing.
:TIMer <num>	Set timer interval (0.001 to 99999.999 sec).

Note: Command shortform is indicated by the uppercase characters. For example, instead of sending ":arm:layer2:source:immediate", you can send ":arm:lay2:sour:imm".

3.7.5 Syntax rules

General form

The general form for SCPI commands is demonstrated in Table 3-2. Notice that they are hierarchical in nature and begin with a root command. For example, to open all channels, you would send the following command:

```
:OPEN ALL
```

The root command for the above example is :ROUTe. This is an optional command word (as indicated by the brackets in the table) and need not be used.

Note that command words are preceded by a colon (:), and that there must be a space between the command and the parameter. In the above example, there is a space between the :OPEN command word and the ALL parameter.

SCPI command words and Common Commands are not case sensitive. They can be sent in uppercase or lowercase. The commands in Table 3-2 show a combination of upper and lowercase characters. The uppercase characters identify the short-form version of the command. For example, all the following versions of the same command are valid:

```
:ARM:LAYER2:SOURCE MANUAL
:ARM:LAY2:SOUR MAN
:arm:layer2:source manual
:arm:lay2:sour man
:Arm:Lay2:Sour Man
:ArM;LaY2:SouR MaN
```

Parameters

As previously mentioned, a parameter is separated from the command word by a space. The parameter can consist of one or more data types such as channel list, real, integer, string, name or boolean. Examples:

1. :open (@ 1!1, 1!2)
2. :open all
3. :scan (@ 1!1:1!10)
4. :trigger:count:auto on
5. :trigger:delay 0.5

1. (@ 1!1, 1!2) — This channel list parameter is used to specify a Channel List. Parentheses ( ) are used to enclose the list of channels. The @ symbol must precede the first channel in the list. The exclamation point (!) is a SCPI delimiter used to separate the slot number from the card relay number. Each channel in the list must be separated by a comma (,).
2. All — This name parameter can instead be used as the parameter for the :OPEN command if you wish to open all channels.
3. (@ 1!1:1!10) — This channel list parameter is used to specify a Scan List. This is the same type of parameter used in Example 1. In this example, Channels 1 through 10 are specified. Notice that the colon (:) is used as a separator for the range limits.
4. On — This boolean parameter is used to enable an automatic scan list count. A "1" could have instead been used. "Off" or "0" will disable the function.
5. 0.5 — This real number parameter sets the delay period in seconds.

Multiple commands

Multiple commands can be sent in the same message as long as they are separated by semicolons (;). For example:

Instead of sending...

```
:open (@1!1)
:close (@1!2)
```

You can send ...

```
:open (@1!1);:close (@1!2)
```

When the above message is sent, the first colon (:) indicates that the following command word is a SCPI root command. When the next colon is detected, the path pointer moves down to the next command level and executes the command. When the path pointer sees the colon (:) after the semicolon (;), it resets to the root and starts over.

Proper use of the path pointer allows commands in the same command level to be serviced without having to re-type the entire command path. For example, the command :ARM:LAYer2:SOURce MANual moves the path pointer down to the last command level in the

path. As a result, the :COUNt, :DELay, and :TIMer commands and their companion query commands can be included in the same message without repeating the entire path. Examples:

Instead of sending...

:arm:lay2:sour man;:arm:lay2:sour?

You can send ...

:arm:lay2:sour man;sour?

Instead of sending...

:trig:coun 1;:trig:del 1;:trig:tim 1

You can send ...

:trig:coun 1;del 1;tim 1

Notice that the colon (:) for the additional commands is not included. Remember, when a colon is seen, the path pointer moves down to the next command level. For example:

:trig:del 1;coun:auto on

When this message is sent, the path pointer moves down one command level for the DELAY and COUNT commands. The colon after the COUNT command then moves the pointer down to the next command level and enables AUTO.

A couple of important points:

1. The path pointer can only move down. It cannot be moved up a level.
2. Each new message (line) must begin with the root command.

3.7.6 Programming examples

The following programming examples are written in Hewlett-Packard BASIC 4.0 programming language. The programs assume that the Model 7001 is set to primary address 7.

Programming example #1 — closing and opening channels

The following program will close channels 1, 3, 4, 5, and 6 of slot 1, and then open them after a short delay:

```
10  OUTPUT 707; "*RST;:open all"
20  OUTPUT 707; ":clos (@ 1!1, 1!3:1!6)"
30  OUTPUT 707; ":clos:stat?"
40  ENTER 707; A$
50  PRINT A$
60  WAIT 3
70  OUTPUT 707; ":rout:open (@ 1!1, 1!3-1!6)"
80  END
```

Line 10 Opens any channels that are closed.
Line 20 Close channels 1, 3, 4, 5, and 6 of slot 1.
Line 30 Request the closed channels.
Line 40 Address 7001 to talk.
Line 50 Display closed channels.
Line 60 Three second delay.
Line 70 Open the channels specified in the channel list.

Programming example #2 — manual scanning

The following program will configure the Model 7001 to perform an infinite number of manual scans of 10 channels for slot 1:

```
10  OUTPUT 707; ":syst:pres"
20  OUTPUT 707; ":scan (@1!1:1!10)"
30  OUTPUT 707; ":init"
40  END
```

Line 10 Return 7001 to :SYSTem:PRESet default configuration (scan count = infinite, channel count = 10 channels, channel control source = manual).
Line 20 Define scan list.
Line 30 Take 7001 out of idle state.

When the above program is run, the scan will arm (ARM indicator on) and then wait for front panel STEP key presses to control the channel scan. After taking the Model 7001 out of remote (press LOCAL key), each press of the STEP key will scan the next channel in the scan list.

Programming example #3 — bus trigger controlled scan

The program in Example #2 is modified so that the channel scan will be controlled by bus triggers (*TRG or GET):

```
10 OUTPUT 707; ":syst:pres"
20 OUTPUT 707; ":scan (@1!1:1!10)"
25 OUTPUT 707; ":trig:sour bus"
30 OUTPUT 707; ":init"
40 END
```

Line 10 Return 7001 to :SYSTem:PRESet default configuration (scan count = infinite, channel count = 10 channels, channel control source = manual).
Line 20 Define scan list.
Line 25 Program channel control source for bus triggers.
Line 30 Take 7001 out of idle state.

When the above program is run, the scan will arm and then wait for bus triggers to control the channel scan. Any of the following two programming statements can be used to provide a bus trigger:

```
OUTPUT 707; "*TRG"
TRIGGER 707
```

Every time one of the above statements is executed, a bus trigger will occur causing the next channel in the scan list to be scanned.

Programming example #4 — timer controlled channel scan

The program in Example #2 is modified so that the channel scan will be controlled by a timer:

```
10 OUTPUT 707; ":syst:pres"
20 OUTPUT 707; ":scan (@1!1:1!10)"
25 OUTPUT 707; ":trig:sour tim"
26 OUTPUT 707; ":trig:tim 0.5"
30 OUTPUT 707; ":init"
40 END
```

Line 10 Return 7001 to :SYSTem:PRESet default configuration (scan count = infinite, channel count = 10 channels, channel control source = manual).
Line 20 Define scan list.
Line 25 Program channel control source for timer.
Line 26 Set timer for 0.5 second interval.
Line 30 Take 7001 out of idle state.

When the above program is run, the scan will arm and scan channels continuously at a 0.5 second rate.

Programming example #5 — timer controlled scan

The program in Example #4 is modified to perform two scans, the first scan will start immediately and the second scan will start 10 seconds after the start of the first scan:

```
10 OUTPUT 707; ":syst:pres"
20 OUTPUT 707; ":scan (@1!1:1!10)"
22 OUTPUT 707; ":arm:lay2:coun 2"
23 OUTPUT 707; ":arm:lay2:sour tim"
24 OUTPUT 707; ":arm:lay2:sour tim 10"
25 OUTPUT 707; ":trig:sour tim"
26 OUTPUT 707; ":trig:tim 0.5"
30 OUTPUT 707; ":init"
40 END
```

Line 10 Return 7001 to :SYSTem:PRESet default configuration (scan count = infinite, channel count = 10 channels, channel control source = manual).
Line 20 Define scan list.
Line 22 Program scan count to 2.
Line 23 Program scan control source for timer.
Line 24 Set timer for 10 second interval.
Line 25 Program channel control source for timer.
Line 26 Set timer for 0.5 second interval.
Line 30 Take 7001 out of idle state.

4

Front Panel Operation

4.1 Introduction

This section covers all aspects of front panel operation. Paragraphs in this section are organized as follows:

4.2 **Power-up procedure:** Covers information on connecting the instrument to line power, and the power-up sequence.

4.3 **Display:** Covers the display formats and lists messages that may appear while using the instrument.

4.4 **Analog backplane:** Explains how two Model 701X series switching cards may be internally connected together through the analog backplane of the Model 7001.

4.5 **Mainframe programming:** Explains how to create a channel list and a scan list. The basic close/open operation and scan operation is covered here.

4.6 **MENU:** Covers miscellaneous operations and selections controlled from the MAIN MENU.

4.7 **CARD CONFIG:** Covers the various configuration operations for the two slots (Card 1 and Card 2) from the CARD CONFIG MENU.

4.8 **SCAN CONFIG:** Covers the CONFIGURE SCAN menu, which is used to configure the various layers of scan operation.

4.9 **Digital I/O port:** Describes the input/output port, which is made up of four output lines and one input line.

4.10 **External triggering:** Covers external triggering using the rear panel BNC connectors.

4.11 **Trigger link:** Covers external triggering using the trigger link.

4.2 Power-up procedure

The Model 7001 can be operated from line voltages from 90-260VAC at line frequencies from 47-440Hz.

4.2.1 Line power connections

Using the supplied power cord, connect the instrument to an appropriate AC power source. The female end of the cord connects to the AC receptacle on the rear panel of the instrument. The other end of the cord connects to a grounded AC outlet.

WARNING

The Model 7001 must be connected to a grounded outlet to maintain continued protection against possible

shock hazards. Failure to use a grounded outlet may result in personal injury or death due to electric shock.

4.2.2 Power switch

To turn on the power, simply push in the front panel POWER switch. Power is on when the switch is at the inner (1) position. To turn off power, press POWER a second time to release the switch.

4.2.3 Power-up sequence

On power-up, the Model 7001 will go through the following sequence:

1. The instrument will perform self-tests on its EPROM and RAM memory elements. If a failure is detected, the instrument will lock up and display the following message:

   No Comm Link

   Note: If a problem develops while the instrument is under warranty, return it to Keithley Instruments, Inc. for repair.

2. If the instrument passes the self-tests, the firmware revision levels and currently selected IEEE-488 address will be displayed. An example of this display is shown as follows:

   Model 7001
   Rev. AXX AY IEEE Addr = 07

   where:

   Rev. AXX is the firmware level for the main CPU.

   Rev. AYY is the firmware level for the display CPU.

   7 is the current IEEE-488 Address. Note that the instrument is shipped from the factory with the address set to 7.

3. The Model 7001 will then perform card identification (Card ID). Card ID is required so that the mainframe can configure itself to operate properly for installed cards. Card ID is described as follows:

   Model 701X series cards — If a Model 701X series card (i.e. 7011, 7012 or 7013) is installed in the mainframe, it will be automatically identified. The operator need not do anything. For example, if a Model 7011 multiplexer card is installed in slot 1 and a Model 7012 matrix card is installed in slot 2, the following message will be displayed briefly:

   #1 = 7011 #2 = 7012

   Non-701X series cards — The Model 7001 cannot automatically identify non-701X series cards. The model numbers of these cards are entered by the user using the Card Configuration menu (see paragraph 4.7). On power-up, the mainframe checks its memory and displays the model number last entered by the user. For example:

   #1 = 7052 #2 = NONE

   "7052" indicates that a Model 7052 card was last assigned to slot 1. There may or may not be a Model 7052 card currently installed in slot 1. The message "NONE" indicates that the user last designated slot 2 to be empty, or the last card installed in the now empty slot was a Model 701X series card. Slot 2 may be empty or it may contain an unassigned non-701X series card.

   "9990" or "9991" indicates that the slot was assigned by the user to simulate a switching card. With "9990" assigned, the mainframe will operate as if a 40 channel multiplexer card is installed. With "9991" assigned, the mainframe will operate as if a 4 × 10 matrix is installed. This simulation mode allows you to develop and test a switching system without having the card installed.

   NOTE

   For non-701X series cards, make sure that the power-up Card ID model number messages correspond to what is actually installed in the mainframe. Use the Card Configuration menu (see paragraph 4.7) to assign the correct model numbers to the slots.

4. After card identification, the instrument will go to the channel status display state (see paragraph 4.3 Display).

4.3 Display

The display of the Model 7001 (see Figure 4-1) is primarily used to display channel status along with the entered channel list or scan list. When not displaying channel status, the display is used for informational type messages, such as menu headings and selections. At the top of the display are annunciators to indicate various states of operation.

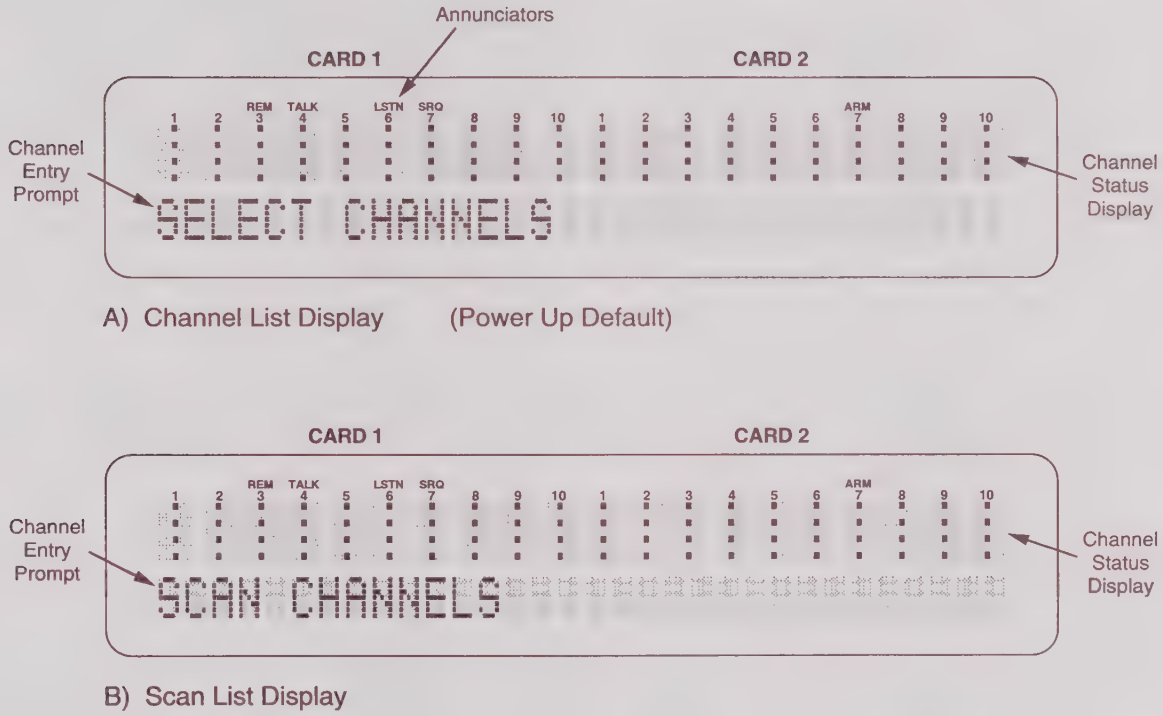

Annunciators
CARD 1
CARD 2
REM TALK LSTN SRQ ARM
1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10
Channel Entry Prompt
SELECT CHANNELS
Channel Status Display
A) Channel List Display (Power Up Default)
CARD 1
CARD 2
REM TALK LSTN SRQ ARM
1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10
Channel Entry Prompt
SCAN CHANNELS
Channel Status Display
B) Scan List Display

Figure 4-1
Display format

4.3.1 Channel status display

The channel status display provides real-time status (open or closed) of each available channel for the two slots; Card 1 and Card 2. Only available channels are displayed. A single "dot" indicates that the available channel is open. A "dash" (5 dots) indicates that the channel is closed (see Figure 4-2).

The channel entry prompt depends on which display mode is currently selected. After power-up, the instrument is in the channel list entry state (see Figure 4-1A) for basic close/open operation. When SCAN LIST is pressed, the instrument goes to the scan list entry state as shown in Figure 4-1B. In general, pressing the EXIT key will select the channel status display, and pressing the SCAN LIST key will toggle between the channel list and the scan list.

Channel designations for the channel status display depend on the type of card installed. For example, if a non-matrix type card (i.e. Model 7011 multiplexer or Model 7013 relay switch card) is installed, the channels would be numbered 1 through 40. Figure 4-3A shows Channel 27 of a non-matrix type card closed. If, however, a matrix card (i.e. Model 7012) is installed, channels are designated as row/column crosspoint coordinates. Figure 4-3B shows matrix crosspoint at Row 3, Column 7 closed.

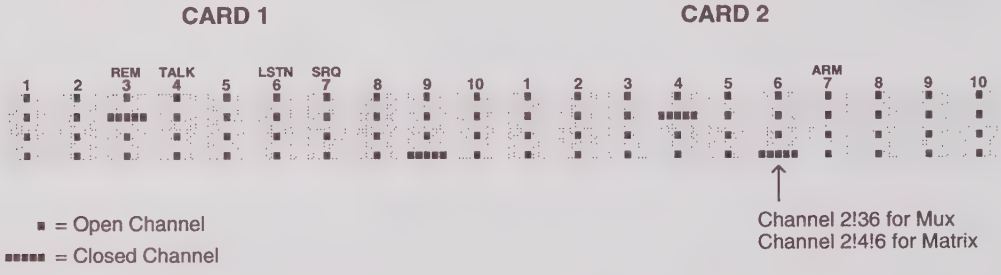


Figure 4-2
Channel status display

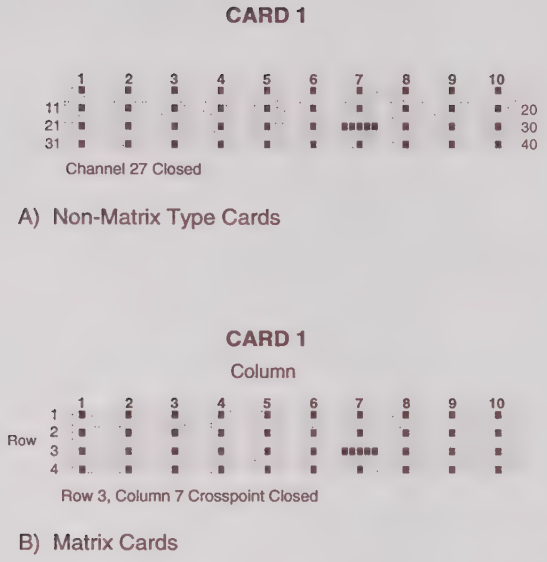

CARD 1
1 2 3 4 5 6 7 8 9 10
11 20
21 30
31 40
Channel 27 Closed
A) Non-Matrix Type Cards
CARD 1
Column
1 2 3 4 5 6 7 8 9 10
Row 1 2 3 4
Row 3, Column 7 Crosspoint Closed
B) Matrix Cards

Figure 4-3
Interpreting channel status display

4.3.2 Information and error messages

When not displaying channel status, the front panel display is used for other information messages, such as menu items, store and recall information, and error and status messages. Error and status messages for the Model 7001 are summarized in Table 4-1.

Also included is a front panel INFO key that displays helpful operating information about the feature you are trying to use. Pressing EXIT or INFO a second time will cancel the message.

4.3.3 Annunciators

The five annunciators along the top of the display indicate the following conditions:

SRQ — Turns on when the unit requests service over the IEEE-488 bus. Programming the Service Request Enable Register allows you to control which conditions will generate an SRQ (see Section 5).

REM —Turns on to indicate that the Model 7001 is in remote when used over the IEEE-488 bus. The Model 7001 can be placed in remote by addressing it to listen with the bus REN line true.

TALK — Turns on to indicate that the Model 7001 is the active talker on the IEEE-488 bus. The unit can be placed in the talker active state by sending it the correct bus talk command, which is derived from the primary address.

LSTN — Turns on when the unit is an active IEEE-488 bus listener. The Model 7001 can be placed in the active listener state by addressing it to listen.

ARM — Turns on when the Model 7001 is taken out of the idle state. A scan can only be performed with the Model 7001 out of the idle state.

Table 4-1
Error and status messages

Code number	Description
+522	"Slot 2 identification error" (EE)
+521	"Slot 1 identification error" (EE)
+510	"Saved state error" (EE)
+173	"Waiting in arm layer 2" (SE)
+172	"Waiting in arm layer 1" (SE)
+171	"Waiting in trigger Layer" (SE)
+161	"Program running" (SE)
+126	"Device calculating" (SE)
+125	"Device measuring" (SE)
+124	"Device sweeping" (SE)
+123	"Device ranging" (SE)
+122	"Device settling" (SE)
+121	"Device calibrating" (SE)
+101	"Operation Complete" (SE)
0	"No error" (SE)
-100	"Command Error" (EE)
-101	"Invalid Character" (EE)
-102	"Syntax Error" (EE
-103	"Invalid Separator" (EE)
-104	"Data Type Error" (EE)
-105	"GET not allowed" (EE)
-108	"Parameter not allowed" (EE)
-109	"Missing Parameter" (EE)
-110	"Command Header Error" (EE)
-111	"Command Header Separator Error" (EE)
-112	"Program mnemonic too long" (EE)
-113	"Undefined header" (EE)
-114	"Header suffix out of range" (EE)
-120	"Numeric data error" (EE)
-121	"Invalid character in number" (EE)
-123	"Exponent too large" (EE)
-124	"Too many digits in number" (EE)
-128	"Numeric data not allowed" (EE)
-140	"Character data error" (EE)
-141	"Invalid character data" (EE)
-144	"Character data too long" (EE)
-148	"Character data not allowed" (EE)
-150	"String data error" (EE)

Table 4-1
Error and status messages

Code number	Description
-151	"Invalid string data" (EE)
-154	"String too long"
-158	"String data not allowed" (EE)
-160	"Block data error" (EE)
-161	"Invalid block data" (EE)
-168	"Block data not allowed" (EE)
-170	"Expression error" (EE)
-171	"Invalid expression" (EE)
-178	"Expression data not allowed" (EE)
-200	"Execution error" (EE)
-201	"Invalid while in local" (EE)
-202	"Settings lost due to rtl" (EE)
-210	"Trigger error" (EE)
-211	"Trigger ignored" (EE)
-212	"Arm ignored" (EE)
-213	"Init ignored" (EE)
-214	"Trigger deadlock" (EE)
-215	"Arm deadlock" (EE)
-220	"Parameter Error" (EE)
-221	"Settings conflict" (EE)
-222	"Parameter data out of range" (EE)
-223	"Too much data" (EE)
-224	"Illegal parameter value" (EE)
-241	"Hardware missing" (EE)
-260	"Expression Error" (EE)
-281	"Cannot create program" (EE)
-282	"Illegal program name" (EE)
-284	"Program currently running" (EE)
-285	"Program syntax error" (EE)
-330	"Self Test failed" (EE)
-350	"Queue overflow" (EE)
-410	"Query interrupted" (EE)
-420	"Query unterminated" (EE)
-430	"Query deadlocked" (EE)
-440	"Query unterminated after indefinite response" (EE)

EE = Error event
SE = Status event

4.4 Analog backplane

The Model 7001 has a three-pole analog backplane that allows the rows or banks of a Model 701X series card installed in one slot to be connected to the rows or banks of a second Model 701X series card installed in the other slot. The three-pole analog backplane of the mainframe is shown in Figure 4-4.

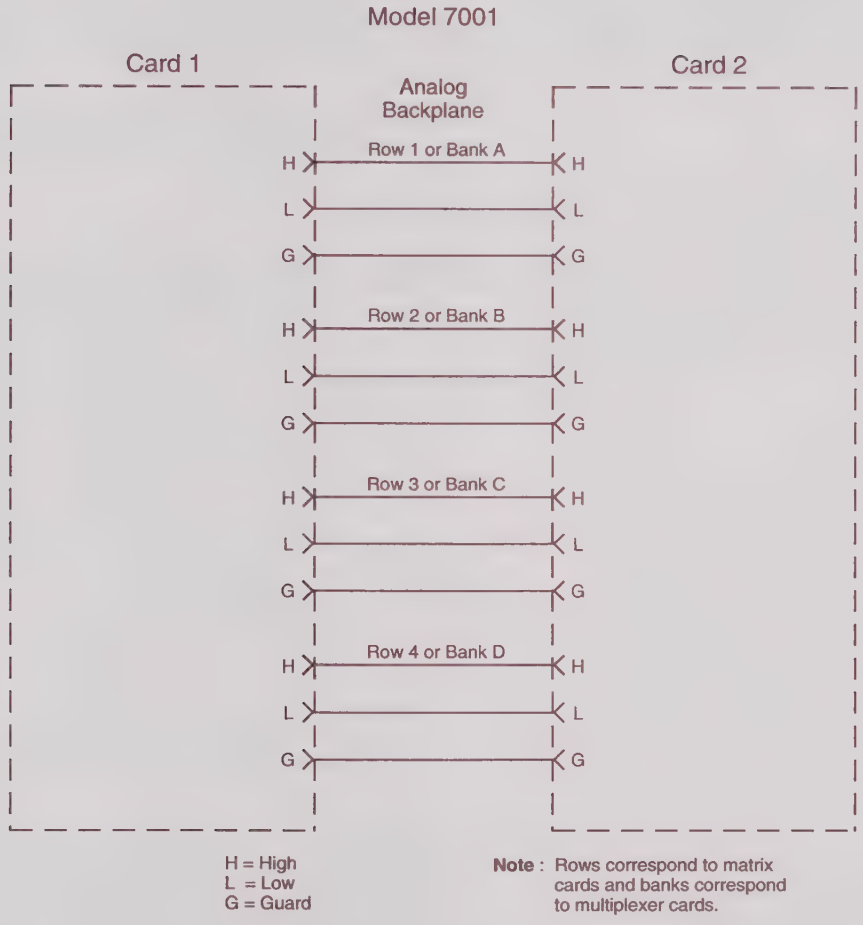


Figure 4-4
Model 7001 analog backplane

For example, if the backplane jumpers of two Model 7012 matrix cards are installed, the rows of the two cards are connected together by simply installing them in the mainframe. The result is a single 4 × 20 matrix. If the backplane jumpers on one or both of the matrix cards were removed, the two cards would be electrically isolated from each other resulting in two separate 4 × 10 matrices. Figure 4-5 shows how the Model 7012 matrix card is connected to the analog backplane. Note that the matrix card has only two poles (High and Low). The third pole (Guard) of the analog backplane is not used.

Keep in mind that not all Model 701X series cards can be connected to the analog backplane of the Model 7001. The Model 7013 Relay Switch Card is made up of 20 individual IN/OUT relay channels. Each channel is electrically isolated from each other. A Model 7013 installed in a slot of the mainframe will be electrically isolated from any other card installed in the other slot.

NOTE

The Model 7001 does not provide an analog backplane for non-701X series cards (such as the Model 7052). A non-701X series card installed in a slot of the mainframe will be electrically isolated from any other card installed in the other slot. The only way to connect one of these cards to a card in the other slot is to wire them together.

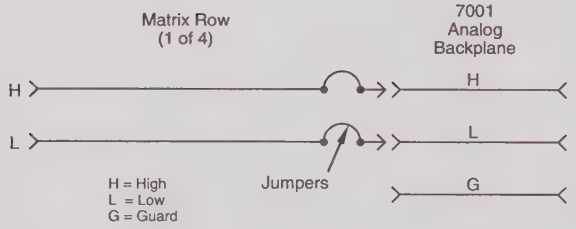


Figure 4-5
Matrix row connections to backplane

4.5 Mainframe programming

The following paragraphs provides detailed information on programming the Model 7001 from the front panel to close channels and perform a scan.

4.5.1 Channel assignments

Channel assignments used to program the mainframe are based on the switching card type and the slot in which it is installed.

Non-matrix type cards: A non-matrix type card, such as the Model 7011 multiplexer card, simply consists of 40 channels (1-40) as shown in Figure 4-3A. When programming the Model 7001, you need to designate the slot in which the card is installed. Thus, combining the slot number with card channel number provides the CHANNEL assignment for the mainframe. The slot and card channel are separated by an exclamation point (!). For the following examples, "CHANNEL" refers to the programming channel assignment for the mainframe, while "Channel" refers to the channel number of the switching card.

CHANNEL 1!1 = Slot 1, Channel 1

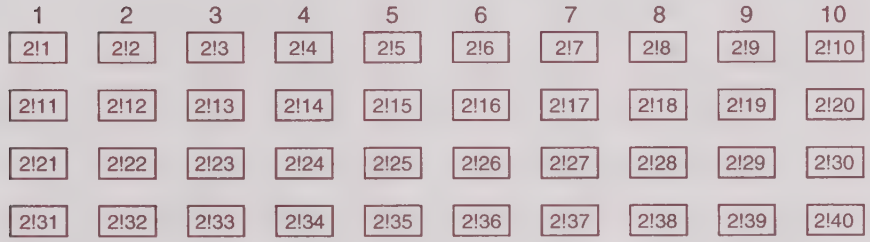
CHANNEL 1!20 = Slot 1, Channel 20

CHANNEL 2!2 = Slot 2, Channel 2

CHANNEL 2!36 = Slot 2, Channel 36

All mainframe channel assignments for non-matrix type switching cards are shown in Figure 4-6.

A. Slot 1 (Card 1)



B. Slot 2 (Card 2)

Examples : 1!18 = Slot 1, Channel 18
2!36 = Slot 2, Channel 36

Figure 4-6
Channel assignments (non-matrix type cards)

Matrix cards: Channels for a matrix card, such as the Model 7012, are organized as row/column crosspoints as shown in Figure 4-3B. When programming the Model 7001, you need to designate the slot in which the card is installed. Thus, combining the slot number with the crosspoint coordinates (row/column) provides the CHANNEL assignment for the mainframe. Slot, row, and column are separated by exclamation points (!). For the following examples, "CHANNEL" refers to the programming channel assignment for the mainframe.

CHANNEL 1!1!1 = Slot 1, Row 1, Column 1

CHANNEL 2!3!6 = Slot 2, Row 3, Column 6

All mainframe channel assignments for matrix cards are shown in Figure 4-7.

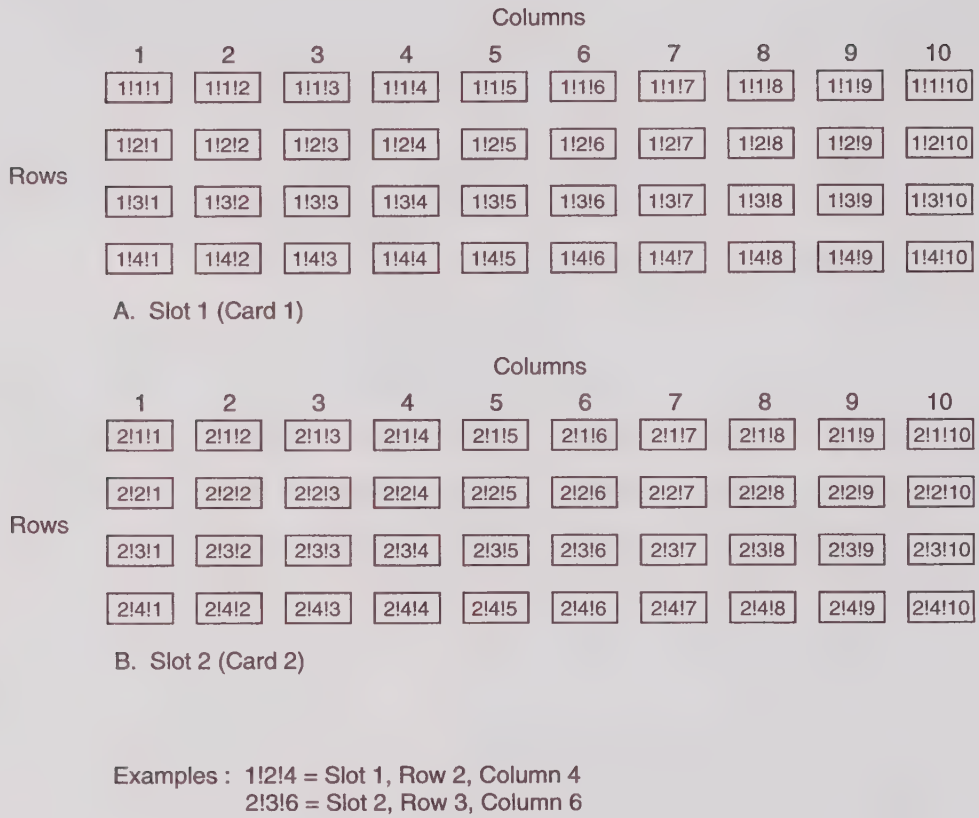


Figure 4-7
Channel assignments (matrix cards)

4.5.2 Channel list and scan list

The Model 7001 can perform two basic operations; it can close and open a list of channels, and it can scan through a list of channels. The following paragraphs explain how to enter channels for these operations. The basic operations are explained in paragraphs 4.5.3 (Closing and Opening Channels) and 4.5.4 (Scanning Channels).

Each operation has its own list. For basic close/open operation, channels are entered into a channel list. For scan operation, channels are entered into a scan list. In general, press EXIT to select the channel status display (if not already displayed as shown in Figure 4-2) and press SCAN LIST to toggle between the channel list and scan list.

A programmed CHANNEL for the mainframe consists of the slot number and the card channel. Slot and card channel are separated by an exclamation point (!). For a matrix card, the card channel consists of a row and column that are also separated by an exclamation point (!). Individual CHANNELS in the defined list are separated by a comma (,). A range of CHANNELS is sepa-

rated by a hyphen (-). A channel pattern stored in memory is designated by the letter "M" followed by the memory location number. Finally, the list is terminated by a comma (,).

For basic close/open operation, the order of channels in the channel list is not important since all listed channels will either close or open at the same time. For scan operation, the order of channels is important. Channels will be scanned in the order that they are presented in the scan list.

Perform the following steps to create a channel list or scan list:

Step 1. Select display mode.

1. If you are entering a list of channels for basic close and open operation, make sure the instrument is in the channel list display state (see Figure 4-1A) with the following message prompt displayed:

   SELECT CHANNELS

   The Model 7001 powers-up to this state. The SCAN LIST key toggles between the channel list and the scan list.

2. If you are entering a list of channels for scan operation, display the scan list:

   SCAN CHANNELS

   Note: If an unwanted list is currently displayed, press CLEAR LIST to clear the display of all listed channels.

Step 2. Enter slot number and card channel.

1. Enter slot number — If the desired channel is on Card 1 (slot 1), press the "1" key on the keypad. If the desired channel is on Card 2 (slot 2), press the "2" key. The separator between slot and channel will automatically be entered after you key in the slot number. For example, if you selected slot 1, the entered channel data will look like this:

   SELECT CHANNELS 1!
   SCAN CHANNELS 1!

2. Enter card channel:
   Non-matrix type card — For a non-matrix type card, use the keypad to enter the card channel number. For example, if you entered channel 20 (with slot 1 previously selected), the entered channel data will look like this:

   SELECT CHANNELS 1!20
   SCAN CHANNELS 1!20

   Matrix card — For a matrix card, use the keypad to first enter the row number (1 through 4), and then the column number. The separator between row and column will automatically be inserted after you enter the row number. For example, if you entered row 3, column 6 (with slot 2 previously selected), the entered channel data will look like this:

   SELECT CHANNELS 2!3!6
   SCAN CHANNELS 2!3!6

   NOTE

   The Model 7001 can store up to 100 channel patterns in memory locations M1 through M100. The closed channels in any one of these patterns can be entered by simply keying in the memory location using the "M" key on the keypad. For example, assume memory location M1 contains 10 closed channels for a specific slot, enter the channel pattern by simply keying in M1 from the keypad. The entered channel data will look like this:

   SELECT CHANNELS M
   SCAN CHANNELS M1

   Paragraph 4.5.5 explains how to store channel patterns into memory.

At this point, the entered channel can be cancelled by pressing the left cursor key (◁).

Step 3. Enter channel separator or terminator.

Channel separators are required for multiple channel entries, and a terminator should be used after the last entered channel.

The comma (,) is used to separate channels, and serves to terminate the list. After entering a channel, as explained in Step 2, press the right cursor key (▷) or ENTER to put in the comma separator. Another channel can then be keyed-in. After the last channel in list is keyed-in, use the ENTER key or the right cursor key (▷) to terminate the list. The comma terminator prevents the last entered channel from being cancelled when the left cursor key (◁) is pressed. The following example shows proper format:

SELECT CHANNELS 1!1, 1!2, 1!3, 1!4, 1!5, 1!6, 1!7, 1!8, 1!9, 1!10, M1,
SCAN CHANNELS 1!1, 1!2, 1!3, 1!4, 1!5, 1!6, 1!7, 1!8, 1!9, 1!10, M1,

The above display indicates that channels 1!1 through 1!10, and the closed channels stored at memory location 1 (M1) are entered.

The hyphen (-) is used to designate a range of channels. After entering the first channel, as explained in Step 2, press the "-" key on the keypad to put in the hyphen, and then key-in the last channel. The following example shows proper format:

SELECT CHANNELS 1!1-1!10, M1,
SCAN CHANNELS 1!1-1!10, M1,

The above display indicates that channels 1!1 through 1!10, and the closed channels stored at memory location 1 (M1) are entered.

Step 4. Repeat the basic procedure in steps 2 and 3 to enter all required channels.

Step 5. Edit the entered list as required.

Edit keys are available to make changes to a list. These keys allow you to change channels, delete channels, or insert channels anywhere in the list. When editing, a channel range (i.e. 1!1-1!6) and a memory location (i.e. M1) are treated as single channel entries.

1. Changing a channel—Perform the following steps to change a channel:
   A. Use the cursor keys to place the cursor at the beginning of the channel entry to be changed.
   B. Key in the new channel entry, and press the right cursor key (▷) or ENTER to add the comma.
2. Deleting a channel — Perform the following steps to delete a channel:
   A. Place the cursor at the beginning of the channel to be deleted.
   B. Press the DELETE key to delete the channel entry.
3. Inserting a channel — Perform the following steps to insert a channel anywhere in the list:
   A. Position the cursor at the desired location in the list. The channel will be inserted between the selected channel entry and the channel entry before it.
   B. Press the INSERT key. The following message will be displayed:

      INSERTING ENTRY

   C. Key in the new channel entry, and press the right cursor key (▷) or ENTER to add the comma.
   D. Press INSERT a second time to cancel the insert edit function.
4. Deleting all channels — The entire list can be cleared by pressing CLEAR LIST.

Summary of channel list and scan list entry keys:

Keypad:

Number keys — Enter slot and channel numbers (row and column for matrix).

"M" and number keys — Enter memory location of stored channels (i.e. M1).

"-" — Define a range of channels (i.e. 1!1-1!9).

"▷" — Enter channel separator (,).

"◁ and ▷" — After terminating list, use cursor keys to select channel entry to be edited.

ENTER: Enter channel separator (,) and list terminator (,) (i.e 1!1,).

INSERT: Create new channel entry at selected location in the list.

DELETE: Clear selected channel entry.

CLEAR LIST: Clear displayed list.

NOTES

1. A scan list is not lost after the instrument is turned off. The last defined scan list will be available the next time the instrument is turned on.

2. When changing card type assignments for non-701X series cards, keep in mind that your scan list may not match the card type. For example, if your scan list is made up of matrix channels (i.e. 1!1!1), it will be mismatched for non-matrix type cards. In this situation, press CLEAR LIST and create a new scan list.
3. A channel list is lost after the instrument is turned off. However, a channel pattern stored in memory can be recalled at any time. The channel list won't be reinstated but the channel status display will update to the saved pattern (see paragraph 4.5.5).

4.5.3 Closing and opening channels

One of the basic capabilities of the Model 7001 is to close (or open) one or more channels specified by the user. All the specified channels will either close or open at the same time. An exception to this is when the Single Channel mode is enabled (see paragraph 4.8.4). With Single Channel mode enabled, only the lowest numbered channel in the lowest numbered slot will close.

This operation is performed with the instrument in the channel list display state. The instrument powers up to the channel list display state.

The procedure to close and open channels requires that you understand how to enter the channels to be controlled. In general, a channel list is entered using the keypad. The number keys are used to enter slot and channel (row and column for a matrix card). The right cursor key (▷) (or ENTER key) adds a comma (,) which is used as a channel separator and list terminator. The hyphen key (-) is used to define a range of channels. Finally, the "M" key is used to enter closed channels of a channel pattern stored in memory. For details, see paragraph 4.5.2.

Perform the following steps to close and open channels:

NOTE

Before performing any close/open operations, make sure the switching cards you are using are properly configured. The CARD CONFIG MENU is used to configure various aspects of operation for the installed card(s). See paragraph 4.7 for details.

Step 1. Place instrument in channel list display state.

If the Model 7001 is not in the channel list display state, press EXIT and/or SCAN LIST until the following message prompt is displayed:

```
SELECT CHANNELS
```

Step 2. Enter channel list.

Enter the channels to be closed/opened as explained in paragraph 4.5.2. The following example demonstrates proper format:

```
SELECT CHANNELS 1!1, 1!2, 2!1-2!5, M1,
```

The above channel list includes channels 1 and 2 of slot 1, channels 1 through 5 of slot 2, and whatever channel pattern is stored in memory location 1 (M1).

Step 3. Close (or open) listed channels.

Perform the appropriate close/open operation as follows:

1. To close the listed channels, press the CLOSE key. The "dashes" on the channel status display will indicate the closed channels.
2. To open the listed channels that are currently closed, press OPEN. Note that only the listed channels will open. Any channels that are closed, but not included in the list, will not open when OPEN is pressed. To open unlisted channels, you must press OPEN ALL.

Note: The OPEN and CLOSE keys are only functional while in the normal channel display state. The OPEN ALL key is functional at all times no matter what is currently being displayed.

Summary of close/open keys:

CLOSE — Close channels defined in channel list.

OPEN — Open channels defined in channel list.

OPEN ALL — Open all closed channels.

4.5.4 Scanning channels

The Model 7001 can scan through a specified list of channels. The order that the channels are presented in the scan list determine the channel order for the scan.

Scan process (Trigger Model)

The following information describes front panel control of the scan process. The flowchart (Trigger Model) in Figure 4-8 summarizes scan operation from the front panel.

Idle

The instrument is considered to be in the idle state whenever it is not operating within one of the layers of the Trigger Model. The front panel ARM indicator is off when the instrument is in the idle state. While in the idle state, the instrument cannot perform a scan.

From the front panel, the Model 7001 is taken out of the idle state by pressing the STEP key. When not in the idle state (ARM indicator on) the scanning function is considered to be enabled.

A scan can be aborted at any time by pressing the OPEN ALL key. The Model 7001 will return to the idle state.

Once the instrument is taken out of the idle state, operation proceeds into the arm layer of the Trigger Model.

Arm layer

NOTE

The arm layer is programmed from the SETUP ARM CONTROL menu (see paragraph 4.8.3).

In general, the instrument requires an arm event to allow operation to proceed to the next layer (scan layer). With Immediate arm spacing selected, operation immediately proceeds to the next layer when the instrument is taken out of the idle state. RESET and factory defaults set arm spacing to Immediate. With one of the other arm spacing events selected, the instrument will wait until the appropriate event occurs.

With Manual arm spacing selected, the instrument will wait until the front panel STEP key is pressed. With GPIB arm spacing selected, the instrument will wait until a bus trigger is received (GET or *TRG). With External arm spacing selected, the instrument will wait until an input trigger (via EXTERNAL TRIGGER connector on rear panel) is received. With TrigLink (Trigger Link) arm spacing selected, the instrument will wait until an input trigger is received (via TRIGGER LINK). With Hold arm spacing selected, the instrument will not respond to any of the arm spacing events.

As can be seen in the flowchart, there is a path that allows operation to loop around the programmed spacing event. This path is called the Source Bypass. When the Source Bypass is enabled (Arm Trigger Control set to Source) and External or TrigLink arm spacing is selected, operation will loop around the spacing event on the initial pass through the arm layer. If programmed for another arm (arm count >1), the bypass loop will not be in effect even though it will be enabled. The Source Bypass loop will reset (be in effect) when operation goes into Idle.

Enabling the Source Bypass also enables the Output Trigger in this layer. When operation returns to the arm layer from the scan layer, an output trigger pulse will occur. If TrigLink arm spacing is selected, the output trigger pulse will be available on the programmed TRIGGER LINK output line. For all other arm spacing selections, the output trigger pulse will be available at

the CHANNEL READY connector. The output trigger for this layer is disabled when the Source Bypass is disabled (Arm Trigger Control set to Acceptor). RESET and factory defaults set Arm Trigger Control to Acceptor.

The instrument can be programmed for additional arms. The arm count can be set to infinity or to a finite value (1 to 9999). RESET and factory defaults set arm count to 1.

After leaving the arm layer, operation proceeds into the scan layer.

Scan layer

NOTE

The scan layer is programmed from the SCAN CONTROL menu (see paragraph 4.8.2).

Operation in the scan layer is similar to operation in the arm layer, except that spacing is controlled by scan events rather than arm events. A timer is available in this layer to control scan spacing. When Timer scan spacing is selected, operation will immediately proceed into the channel layer on the initial pass through the scan layer. Each additional scan (1 to 9999 or infinite) will not occur until the programmed timer interval elapses. The timer can be set to an interval from 1msec to 99999.999 seconds.

The Source Bypass and Output Trigger function in the same manner as the Source Bypass and Output Trigger in the arm layer. The Source Bypass (if enabled) will reset (back in effect) after all programmed scans are completed.

RESET and factory defaults set scan spacing to Immediate, scan count to infinite and Scan Trigger Control to Acceptor.

After leaving the scan layer, operation proceeds into the channel layer.

Channel layer

NOTE

The channel layer is programmed from the CHANNEL CONTROL menu (see paragraphs 4.8.1).

Operation in the channel layer is similar to operation in the scan layer, except that spacing is controlled by channel events rather than scan events, and the Output Trigger is always enabled.

When Timer channel spacing is selected, the first channel will be scanned immediately. Each additional channel is then scanned at a rate determined by the programmed timer interval (1msec to 99999.999 seconds). With Immediate channel spacing selected, channels will be scanned immediately. The scan rate will primarily be determined by the internally set relay settling time and any user programmed delay (see paragraph 4.7.4). For Model 701X series cards, the internal relay settling time is 6msec; 3msec after the relay closes and 3msec after the relay opens. The user programmed delay is in addition to the relay settling time.

The device action (scan channel) for each channel includes:

1. If not the first channel in the scan, open the previous channel and wait for the internal settling delay to time out.
2. Close the next channel in the scan and wait for the internal settling delay to time out.
3. Wait for the user programmed delay (0 to 99999.999 seconds) to time out.

The Source Bypass (if enabled) will reset (be in effect) after the programmed number of channels are scanned.

The Output Trigger for the channel layer is always enabled and occurs after each channel is scanned (device action). For all channel spacing selections, except TrigLink, the TTL Output Trigger Pulse is available at the CHANNEL READY connector. For TrigLink channel spacing, the Output Trigger functions as follows:

1. If the asynchronous Trigger Link mode is selected, the TTL Output Trigger pulse will be available on the programmed Trigger Link output line.
2. If the semi-synchronous Trigger Link mode is selected and the Source Bypass is disabled (Channel Trigger Control set for Acceptor), the Trigger Link line will be released (goes high).
3. If the semi-synchronous Trigger Link mode is selected, and the Source Bypass is enabled (Channel Trigger Control set for Source), the Trigger Link line will be pulled down low and then released.

See paragraph 4.11 for details on the Trigger Link.

RESET and factory defaults set channel spacing to Manual, channel count to the scan list length, and Channel Trigger Control to Source.

Scan list

Scanning channels requires that you understand how to enter channels for the scan list. In general, a channel is entered using the keypad. The number keys are used to enter the slot and channel (row and column for a matrix card). The right cursor key (▷) (or ENTER key) adds a comma (,) which is used as a channel separator or list terminator. The hyphen key (-) is used to define a range of channels. Finally, the "M" key is used to enter a channel pattern stored in memory. For details, see paragraph 4.5.2.

When a channel pattern is scanned, the closed switches in the pattern will close and remain closed for the duration of the scan. A channel pattern is useful for supplying bias voltages in a test system.

Scan procedure

Perform the following steps to scan channels:

NOTE

Before performing scan operation, make sure the switching cards that you are using are properly configured. The CARD CONFIG menu is used to configure various aspects of operation for the installed card(s). See paragraph 4.7 for details.

Step 1. Press OPEN ALL.

Before configuring a scan, you should place the Model 7001 in the idle state by pressing OPEN ALL. This will stop any scan that is currently in process, open all channels, and place the Model 7001 in the idle state.

Step 2. Create a scan list.

With the instrument in the scan list display state, enter the channels to be scanned as explained in paragraph 4.5.2. The following example demonstrates proper format:

SCAN CHANNELS 1!1, 1!2, 2!1-2!5, M1,

The above scan list includes channels 1 and 2 of slot 1, channels 1 through 5 of slot 2, and whatever closed channels are stored in memory location 1. Channels will be scanned in the order that they are presented in this list. M1 will be treated as a single channel. If for example, M1 is made up of two closed channels, those two channels will close and remain closed when M1 is scanned.

At the conclusion of a scan, the last channel in the list will remain closed. If you wish to open the last channel, specify a memory location that has no closed channels as the last entry in the scan list. For example, if in the above scan list M1 has no closed channels, Channel 2!5 will open at the conclusion of a single scan.

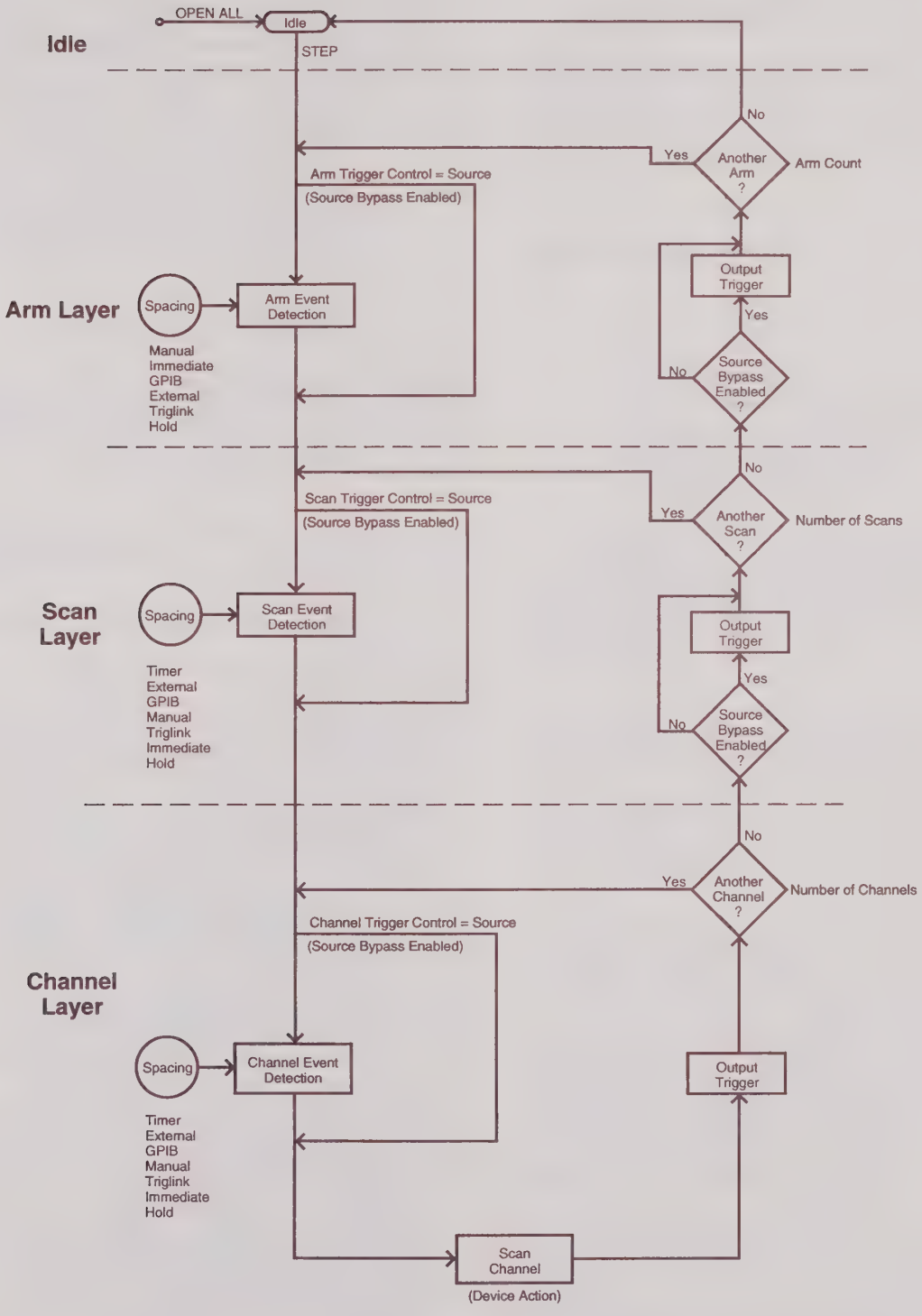


Figure 4-8
Trigger Model (Front panel scan operation)

Step 3. Configure the Channel Layer of the scan.

The channel layer is programmed from the CHAN CONTROL menu of the CONFIGURE SCAN menu. Detailed information on using the CHANNEL CONTROL menu is provided in paragraph 4.8.1 and Table 4-6.

The following procedure summarizes the steps to configure the channel layer:

1. From the CONFIGURE SCAN menu, select CHAN CONTROL.
2. From the CHANNEL CONTROL menu, select CHANNEL-SPACING.
3. From the SELECT CHAN SPACING menu, select one of the following events (or IMMEDIATE) to control the process of scanning channels:
   A. TIMER — Use to set a time interval (1msec to 99999.999 seconds) between channels.
   B. EXTERNAL — With this selection, external triggers control channel spacing. Each trigger applied to the rear panel EXTERNAL TRIGGER connector will select the next channel of the scan.
   C. GPIB — With this selection, bus triggers (GET or *TRG) control channel spacing. Each bus trigger received by the Model 7001 will select the next channel of the scan.
   D. MANUAL — With this selection, the front panel STEP key is used to control channel spacing. Each press of the STEP key will select the next channel of the scan.
   E. TRIGLINK — With this selection, triggers received over the Trigger Link will control channel spacing. Each trigger will select the next channel in the scan.
   F. IMMEDIATE — With this selection, events are not used to control channel spacing. Only the time delay for relay settling and an optional DELAY (see paragraph 4.7) programmed by the user affect channel spacing in the scan.
4. From the CHANNEL CONTROL menu, select NUMBER OF CHANS.
5. From the NUMBER OF CHANNELS menu, select one of following items to specify the number of channels to scan:
   A. USE SCANLIST LENGTH — With this selection, a single scan of all the channels in the scan list will occur for every programmed scan (scan count).
   B. CHAN-COUNT — With this selection, you have the following two options for CHANNEL COUNT:
      a. INFINITE — With this count selection, the channel scan will repeat indefinitely.
      b. ENTER-CHAN-COUNT — Use this selection to define the number of channels (1 to 9999) to scan. The channel scan wraps around and continues to satisfy a channel count that exceeds the scan list length.

Step 4. Configure the Scan Layer of the scan.

The scan layer is programmed from the SCAN CONTROL menu of the CONFIGURE SCAN menu. Detailed information on using the SCAN CONTROL menu is provided in paragraph 4.8.2.

The following procedure summarizes the steps to configure the scan layer:

1. From the CONFIGURE SCAN menu, select SCAN CONTROL.
2. From the SCAN CONTROL menu, select SCAN SPACING.
3. From the SELECT SCAN SPACING menu, select one of the following events (or IMMEDIATE) to control scan spacing:
   A. TIMER — Use to set a time interval (1msec to 99999.999 seconds) between scans.
   B. EXTERNAL — With this selection, external triggers control scan spacing. A trigger applied to the rear panel EXTERNAL TRIGGER connector will allow operation to proceed to the channel layer.
   C. GPIB — With this selection, bus triggers (GET or *TRG) control scan spacing. A bus trigger received by the Model 7001 will allow operation to proceed to the channel layer.
   D. MANUAL — With this selection, the front panel STEP key is used to control scan spacing. Each press of the STEP key will allow operation to proceed to the channel layer.
   E. TRIGLINK — With this selection, triggers received over the Trigger Link will control scan spacing. A trigger will allow operation to proceed to the channel layer.
   F. IMMEDIATE — With this selection, events are not used to control scan spacing. Operation will proceed immediately to the channel layer.

4. From the SCAN CONTROL menu, select NUMBER-OF-SCANS.
5. From the NUMBER OF SCANS menu, select one of following items to specify the number of scans to be performed:
   A. INFINITE — With this selection, the scan will repeat indefinitely.
   B. ENTER-SCAN-COUNT — Use this selection to define the number of scans (1 to 9999) to be performed.

Step 5. Configure the Arm Layer of the scan.

The arm layer is programmed from the ARM CONTROL menu of the CONFIGURE SCAN menu. Detailed information on using the ARM CONTROL menu is provided in paragraph 4.8.3.

The following procedure summarizes the steps to configure the arm layer:

1. From the CONFIGURE SCAN menu, select ARM CONTROL.
2. From the SETUP ARM CONTROL menu, select ARM SPACING.
3. From the SELECT ARM SPACING menu, select one of the following events (or IMMEDIATE) to control the interval between arms:
   A. MANUAL — With this selection, the front panel STEP key is used to control arm spacing. Pressing the STEP key will allow operation to proceed to the scan layer.
   B. IMMEDIATE — With this selection, events are not used to control arm spacing. Operation will proceed immediately to the scan layer.
   C. GPIB — With this selection, bus triggers (GET or *TRG) control arm spacing. A bus trigger received by the Model 7001 will allow operation to proceed to the scan layer.
   D. EXTERNAL — With this selection, external triggers control arm spacing. A trigger applied to the rear panel EXTERNAL TRIGGER connector will allow operation to proceed to the scan layer.
   E. TRIGLINK — With this selection, triggers received over the Trigger Link will control arm spacing. A trigger will allow operation to proceed to the scan layer.
4. From the SETUP ARM CONTROL menu, select ARM COUNT.
5. From the ARM-COUNT menu, select one of following items to specify the number of arms to be performed:
   A. INFINITE — With this selection, the number of arms is infinite.
   B. ENTER-ARM-COUNT — Use this selection to define the number of arms (1 to 9999) to be performed.

Step 6. Start the scan.

NOTE

To view the scan, exit from the CONFIGURE SCAN menu by pressing EXIT until the instrument returns to the channel status display state. If needed, press SCAN LIST to display the channels to be scanned.

Step 1 of this procedure placed the Model 7001 in the idle state. In this idle state, a scan cannot be performed. The Model 7001 is taken out of the idle state by pressing the STEP key.

Once out of the idle state, the scan is considered enabled. The scan will proceed according to how the three layers are programmed. If Immediate spacing is selected, operation will pass immediately into the next layer. If spacing is programmed for a particular event, operation will not pass into the next layer until the event occurs.

Scanning examples:

The following examples assume two scans of a two-channel scan list. All events in these examples can be substituted by the STEP key. For example, if the instrument is waiting for an EXTERNAL trigger event, you can instead press STEP to provide the event.

Example 1:

ARM SPACING = IMMEDIATE

SCAN SPACING = TIMER, EXTERNAL, GPIB, MANUAL or TRIGLINK

CHANNEL SPACING = TIMER, EXTERNAL, GPIB, MANUAL or TRIGLINK

1. Press OPEN ALL to open all channels and place the Model 7001 in the idle state.
2. Press STEP to take the 7001 out of the idle state (ARM indicator turns on).
3. The first scan spacing event will pass operation into the channel layer.
4. The first channel spacing event will scan the first channel in the scan list.
5. The next channel spacing event will scan the second channel.
6. The next scan spacing event will pass operation back into the channel layer.
7. The next channel spacing event will scan the first channel.
8. The next channel spacing event will scan the second channel and disarm (idle) the scan.

Example 2:

ARM SPACING = IMMEDIATE

SCAN SPACING = IMMEDIATE

CHANNEL SPACING = TIMER, EXTERNAL, GPIB, MANUAL or TRIGLINK

1. Press OPEN ALL to open all channels and place the Model 7001 in the idle state.
2. Press STEP to take the 7001 out of idle state, and operation into the channel layer.
3. The first channel spacing event will scan the first channel.
4. The next channel spacing event will scan the second channel.
5. Operation passes automatically back into the channel layer since IMMEDIATE scan spacing is selected.
6. The next channel spacing event will scan the first channel.
7. The next channel spacing event will scan the second channel and disarm (idle) the scan.

Example 3:

ARM SPACING = MANUAL, GPIB, EXTERNAL or TRIGLINK

SCAN SPACING = TIMER, EXTERNAL, GPIB, MANUAL or TRIGLINK

CHANNEL SPACING = TIMER, EXTERNAL, GPIB, MANUAL or TRIGLINK

1. Press OPEN ALL to open all channels and place the Model 7001 in the idle state.
2. Press STEP to take the 7001 out of the idle state.
3. The arm spacing event allows operation to pass into the scan layer.
4. The first scan spacing event passes operation into the channel layer.
5. The first channel spacing event will scan the first channel in the scan list.
6. The next channel spacing event will scan the second channel.
7. The next scan spacing event will pass operation back into the channel layer.
8. The next channel spacing event will scan the first channel.
9. The next channel spacing event will scan the second channel and disarm (idle) the scanner.

Example 4:

ARM SPACING = MANUAL, GPIB, EXTERNAL or TRIGLINK

SCAN SPACING = IMMEDIATE

CHANNEL SPACING = TIMER, EXTERNAL, GPIB, MANUAL or TRIGLINK

1. Press OPEN ALL to open all channels and place the Model 7001 in the idle state.
2. Press STEP to take the 7001 out of the idle state.
3. The arm spacing event allows operation to pass into the scan layer.
4. Operation passes immediately into the channel layer since IMMEDIATE scan spacing is selected.
5. The first channel spacing event will scan the first channel in the scan list.
6. The next channel spacing event will select the second channel.
7. Operation passes automatically back into the channel layer since IMMEDIATE scan spacing is selected.
8. The next channel spacing event will select the first channel.
9. The next channel spacing event will select the second channel and disarm (idle) the scan.

Scanning notes:

1. The STEP key is always functional during a scan and can be used to provide a spacing event. For example, if programmed for TIMER channel spacing, the STEP key can also be used to select the next channel.
2. Forbidden Channels cannot be entered into the scan list.
3. With Single Channel enabled, only the lowest numbered channel in a memory location (i.e. M1) will close when selected.
4. Card Pair is functional during a scan. The channels included in the scan list and the corresponding channels for the other slot will be scanned.

Summary of scan keys:

OPEN ALL — Use to stop a scan, open all channels, and place the Model 7001 in the scan idle state.

STEP — Use to take the Model 7001 out of the idle state; and also, use to manually step through a scan.

4.5.5 Storing channel patterns (STORE and RECALL)

Any displayed channel pattern can be stored in memory locations M1 through M100. A channel pattern is simply a pattern of open and closed channels.

Storing channel patterns

Perform the following steps to store a channel pattern in a memory location:

Step 1. Place instrument in channel list display state.

SELECT CHANNELS

Step 2. If there are any undesired channels currently closed, press OPEN ALL to open them.

Step 3. Enter channels that you wish to close.

Channel list entry is explained in paragraph 4.5.2. The following example demonstrates proper format:

SELECT CHANNELS 1!1, 1!2, 2!4,

The above channel list includes channels 1 and 2 of slot 1, and channel 4 of slot 2.

Step 4. Close channels.

Close the channels specified in the list by pressing CLOSE.

Step 5. Store the displayed channel pattern.

Perform the following steps to store the channel pattern:

1. Press STORE. The following typical message will be displayed:

   STORE CHANS AT #001

   The above message indicates that the channel pattern will be stored at memory location M1.

   NOTE

   You can exit from the Store mode without storing the channel pattern by pressing EXIT. The instrument will return to the channel list display state.

2. If you wish to store the channel pattern at the displayed memory location, proceed to step 3. Otherwise, use the cursor keys (◁ and ▷) and the number keys to key in the desired memory location (001 to 100).
3. To store the channel pattern at the displayed memory location, press ENTER. The instrument will return to the channel status display state.

Recalling channel patterns

There are two ways to recall a channel pattern. One way is to immediately access the channel pattern from memory using RECALL. The open/close channel pattern will be displayed on the Model 7001 indicating the actual state of each channel. The other way is to specify the memory location (i.e. M1) of the channel pattern in the channel list and/or scan list. The closed channels in the channel pattern will close when that memory location is closed or scanned.

Recalling a channel pattern using RECALL

Perform the following steps to use RECALL:

1. While in channel list or scan list display states, press RECALL to display the following typical message:

   RECALL CHANS AT #001

   The above message indicates that the channel pattern will be recalled from memory location M1.

   NOTE

   You can exit from the Recall mode without recalling the channel pattern by pressing EXIT. The instrument will return to the channel list display state.

2. If you wish to recall the channel pattern from the displayed memory location, proceed to step 3. Otherwise, use the cursor keys (◁ and ▷) and the number keys to key in the desired memory location (001 to 100).
3. To recall the channel pattern from the displayed memory location, press ENTER. The instrument will return to the channel status display state and display the recalled channel pattern.

CAUTION

As soon as the display updates to the selected channel pattern, the corresponding relays on the card will also update. Thus, make sure you want to energize the card relays before recalling a channel pattern.

Recalling a channel pattern via channel list and/or scan list

A channel pattern can be recalled by specifying the memory location in a channel list and/or scan list. For example, assume a channel pattern that has Channels 2!11 and 2!36 closed is stored at memory location M10. Also assume that M10 is included in the following channel list:

SELECT CHANNELS 1!1, 1!4, M10,

When CLOSE is pressed with the above channel list displayed, Channels 1!1, 1!4, 2!11 and 2!36 will close.

Now assume the M10 is included in the following scan list:

SCAN CHANNELS 1!1, 1!4, M10, 1!6,

When M10 is selected in the scan, both Channels 2!11 and 2!36 will be closed at the same time and will remain closed when channel 1!6 is scanned.

4.6 MENU

Various instrument operations to configure the Model 7001 are performed using the front panel MENU. The MENU structure is shown and summarized in Table 4-2.

General rules to use MENU

1. The MAIN MENU is displayed by placing the instrument in the normal channel display state, and then pressing the MENU key. If already in the menu structure, the MAIN MENU can be displayed by pressing and releasing the EXIT key un-

Table 4-2
MENU structure

Menu item	Description
SAVESETUP	Setup Menu:
SAVE	Save setup at a memory location (up to 10).
RESTORE	Return 7001 to setup stored at a memory location.
PWRON	Power-on Menu:
FACTORY DEFAULT	Power-on to factory default setup conditions.
USER SETUP	Power-on to setup stored at a memory location.
RESET	Return 7001 to original power-on setup.
GPIB	GPIB Setup Menu:
ADDRESS	Check/change IEEE-488 address.
STATUS	Display IEEE-488 status byte.
DIGITAL-I/O	Digital I/O Menu:
OUTPUT-STATUS	Check/change states of digital output channels.
OUTPUT-POLARITY	Check/change polarity of digital output port.
INPUT-STATUS	Read digital input channel.
TEST	Self-Test Menu:
BUILT-IN TESTS	Test Digital Board:
AUTO	Run all tests automatically
MANUAL	Select tests to run
DISPLAY TESTS	Test Display Board:
KEYS	Verify operation of front panel keys
PATTERNS	Verify operation of display
LANGUAGE	Choose 7001Language:
ENGLISH	Display messages in English.
GERMAN	Display messages in German.
FRENCH	Display messages in French.
GENERAL	General Menu:
SERIAL #	Displays serial number, SCPI version, and software revision.
STATUS-MESSAGES	Enables/disables status message mode.

til the MAIN MENU selections are displayed (see next rule). The MAIN MENU selections are shown as follows:

```
MAIN MENU
SAVESETUP     GPIB          DIGITAL-I/O▶
◀ TEST        LANGUAGE      GENERAL
```

2. Pressing the EXIT key causes the display to back up to the previous menu level. Also, keyed-in parameter changes are ignored if an EXIT is performed. When the MAIN MENU is displayed, pressing EXIT or MENU will disable MENU.
3. The position of the cursor is denoted by the blinking menu selection or parameter. The cursor is moved from one item to the next using the cursor keys (◁ and ▷).
4. A displayed arrow (◀ or ▶) indicates that there is more information or additional menu items to select from. When "▶" is displayed, use the▷ cursor key to display the additional message(s); and conversely, when "◀" is displayed, use the ◁ cursor key.
5. A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the appropriate key on the keypad. After keying in a number, the cursor will move to the next digit to the right.
6. A parameter change is only executed when the ENTER key is pressed.
7. ENTERing an invalid parameter generates an error and ignores the entry.
8. The INFO key can be used anywhere in the menu structure to display helpful information messages concerning operation. To cancel an information message, press EXIT or INFO a second time.

4.6.1 SAVESETUP

The SAVESETUP menu is used for the following operations:

- Save the current setup conditions in memory for future recall. Up to 10 setups can be saved in memory.
- Restore the instrument to setup conditions stored in memory.
- Setup the power-on (PWRON) configuration. The instrument can be set to power-on to the factory default setup conditions, or power-on to the setup conditions stored at a specified memory location.
- Reset the instrument to the original power-on setup conditions (see Table 4-3).

Perform the following steps to display the SAVESETUP menu:

1. Display the MAIN MENU (see paragraph 4.6, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on SAVESETUP, and press ENTER to access the following menu:

```
SETUP MENU
SAVE      RESTORE      PWRON      RESET
```

SAVE — Use this menu item to save the current setup conditions in memory at a specified memory location. To select SAVE, place the cursor on SAVE and press ENTER. The following typical message will be displayed:

```
SAVE SETUP #0 (0-9)
```

1. To save the current setup at the displayed memory location, press ENTER. The instrument will return to the SETUP MENU.
2. To save the current setup to a different memory location, key in a value (0 to 9) and press ENTER. The instrument will return to the SETUP MENU.

RESTORE — Use this menu item to return the instrument to the setup conditions that are stored in memory at a specified memory location. To select RESTORE, place the cursor on RESTORE and press ENTER. The following typical message will be displayed:

```
RESTORE SETUP #0
```

1. To restore the instrument to the setup conditions stored at the displayed memory location, press ENTER. The instrument will return to the SETUP MENU.
2. To restore the instrument to the setup conditions stored at a different memory location, key in the memory location (0 to 9) and press ENTER. The instrument will return to the SETUP MENU.

PWRON — Use this menu item to select the setup conditions that the instrument will power-on to. To select the PWRON menu item, place the cursor on PWRON and press ENTER. The following menu will be displayed:

```
SET POWER-ON DEFAULT
FACTORY-DEFAULT    USER-SETUP
```

FACTORY DEFAULT — With this selection, the instrument will return to the factory default conditions (see Table 4-3) the next time it is turned on. To select the FACTORY-DEFAULT menu item, place the cursor on FACTORY-DEFAULT and press ENTER. The instrument will return to the SETUP MENU.

USER SETUP — Using this selection, the instrument will power-on to the setup conditions saved at a specified memory location. To select USER-SETUP, place the cursor on USER-SETUP and press ENTER. The following typical message will then be displayed:

```
PWRON DEFAULT = #0
```

1. To power-on to the setup conditions stored at the displayed memory location, press ENTER. The instrument will return to the SETUP MENU.
2. To power-on to setup conditions stored at a different memory location, key in the memory location (0 to 9) and press ENTER. The instrument will return to the SETUP MENU.

RESET — Use this menu item to reset the instrument to the RESET default setup conditions (see Table 4-3). To select RESET, place the cursor on RESET and press ENTER. The following message will be displayed:

```
RESETTING INSTRUMENT
```

Press ENTER to display:

```
RESET COMPLETE
```

Press ENTER to return to the SETUP MENU.

4.6.2 GPIB

The GPIB menu is used for the following operations:

- Check and/or change the address of the IEEE-488 bus.
- Display the status byte of the IEEE-488 bus.

Perform the following steps to display the GPIB menu:

1. Display the MAIN MENU (see paragraph 4.6, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on GPIB, and press ENTER to display the following menu:

```
GPIB SETUP MENU
ADDRESS      STATUS
```

ADDRESS — Use this menu item to check and/or change the IEEE-488 address. At the factory the address is set to 7, but can be changed to any value from 0 to 30. To select ADDRESS, place the cursor on ADDRESS and press ENTER. If the address is currently set to 7, the following message will be displayed:

```
ADDRESS = 07 (0-30)
```

1. To retain the displayed address, press ENTER or EXIT. The instrument will return to the GPIB SETUP MENU.
2. To change the address, simply key in a valid value (0 to 30) and press ENTER. The instrument will return to the GPIB SETUP MENU.

STATUS — Use this menu item to display the IEEE-488 status byte. Refer to Section 4 (IEEE-488 Reference) for information on the status byte. To select STATUS, place the cursor on STATUS and press ENTER. If for example, all bits of the status byte are reset to zero, it will be displayed as follows:

```
SHOW STATUS BYTE
   EVA = 0      QSB = 0      MAV = 0      ESB = 0 ▶
◀  MSS = 0      OSB = 0
```

When finished viewing the status byte, press either ENTER or EXIT. The instrument will return to the GPIB SETUP MENU.

Table 4-3
Default conditions

Item	Factory default	RESET
Channel status	All open	All open
Channel list	Cleared	No change
Scan list	Cleared	No change
GPIB address	7	No change
Digital I/O output level	High	High
Language	English	No change
Status messages	Off	Off
# of poles	2-pole (both slots)	No change
Card pair	Off	Off
Delay	0 sec	0 sec
Channel spacing	Manual (STEP key)	Manual (STEP key)
Number of channels	Scan list length	Scan list length
Channel trigger control	Source	Source
Scan spacing	Immediate	Immediate
Number of scans	Infinite	Infinite
Scan trigger control	Acceptor	Acceptor
Arm spacing	Immediate	Immediate
Arm count	1	1
Arm trigger control	Acceptor	Acceptor
Single channel	Off	Off
Restricted channels	None	No change

Note: "No change" indicates that RESET does not affect the currently set condition.

4.6.3 DIGITAL-I/O

The DIGITAL-I/O menu is used for the following operations:

- Check and/or change the OUTPUT-STATUS (on or off) of the four digital output channels.
- Check and/or change the OUTPUT-POLARITY of the digital output port. Polarity can be active-high (on = +5V) or active-low (on = 0V).
- Check the INPUT-STATUS (on or off) of the single digital input channel.

NOTE

The digital output port uses default levels of 0V and +5V. However, a user supplied voltage level of up to 30V can be used instead of the 5V level (see paragraph 4.9.1).

Perform the following steps to display the DIGITAL-I/O MENU:

1. Display the MAIN MENU (see paragraph 4.6, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on DIGITAL-I/O and press ENTER to access the following menu:

```
DIGITAL-I/O MENU
OUTPUT-STATUS        OUTPUT-POLARITY ▶
◀ INPUT-STATUS
```

OUTPUT-STATUS — Use this menu item to check and/or change the state (on or off) of the four digital output channels. The actual level of an "on" channel is determined by the polarity, which is controlled by the next menu item (OUTPUT-POLARITY). To select OUTPUT-STATUS, place the cursor on OUTPUT-STATUS and press ENTER. If for example, all the digital output channels are off, the following message will be displayed:

```
DIGITAL OUTPUT LINES
1 = OFF    2 = OFF    3 = OFF    4 = OFF
```

1. To retain the displayed states of the output channels, press ENTER or EXIT. The instrument will return to the DIGITAL-I/O MENU.
2. To change the state of one or more digital output channels, perform the following steps:
   A. Position the cursor at the channel that you wish to change.
   B. Press any one of the keys on the keypad. These keys simple toggle between "ON" and "OFF".
   C. Repeat steps A and B for each channel that you wish to change.
   D. With the desired states displayed, press ENTER. The instrument will return to the DIGITAL-I/O MENU.

OUTPUT-POLARITY — Use this menu item to check and/or change the polarity of the digital output port. The polarity of each channel can be active-high (ON = +5V) or active low (ON = 0V). To select OUTPUT-POLARITY, place the cursor on OUTPUT-POLARITY and press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
TTL1    TTL2    TTL3    TTL4
```

1. Place the cursor on the appropriate channel and press ENTER. A message indicating the polarity of the selected channel will be displayed. For example:

```
TTL1 LOGIC SENSE
ACTIVE-HIGH          ACTIVE-LOW
```

   Cursor position will indicate the polarity of the channel.
2. To retain the currently selected polarity, press ENTER or EXIT. The display will return to the SELECT OUTPUT LINE MENU.
3. To change polarity, place the cursor on the alternate selection using the cursor keys (◁ or ▷) and press ENTER. The instrument will return to the SELECT OUTPUT LINE MENU.
4. When finished, press EXIT to return to the DIGITAL I/O MENU.

INPUT-STATUS — Use this menu item to read (on or off) the digital input channel. Polarity is fixed at active-high (ON = 5V).

To select INPUT-STATUS, place the cursor on INPUT-STATUS and press ENTER. If for example, the digital input channel is "on", the following message will be displayed:

```
DIGITAL INPUT LINE
Status = ON
```

Press ENTER or EXIT to return the instrument to the Digital I/O Menu.

4.6.4 TEST

The TEST menu is to be used as a diagnostic tool to isolate problems with the Model 7001. Refer to Section 7 Maintenance for information on using these test procedures.

4.6.5 LANGUAGE

The LANGUAGE menu is used to change the language for display messages. Language selections include:

- Display messages in ENGLISH.
- Display messages in GERMAN.
- Display messages in FRENCH.

Perform the following steps to change the language of menu display messages:

1. Display the MAIN MENU (see paragraph 4.6, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on LANGUAGE and press ENTER. The following language menu selections will be displayed:

   CHOOSE MENU LANGUAGE
   ENGLISH GERMAN FRENCH

   The cursor will be located on the currently selected language. Note that if a language other than English is currently selected, the menu will be displayed in the selected language.

3. To retain the currently selected language, press EXIT or ENTER. The display will return to the MAIN MENU.
4. To select one of the other languages, place the cursor on the desired language selection and press ENTER. The instrument will return to the MAIN MENU.

   Note: The selected language becomes the power-up default.

4.6.6 GENERAL

The GENERAL MENU is used for the following operations:

- Serial # of the Model 7001.
- SCPI version control number.
- Software revision level installed in the Model 7001.
- Select the Status Message Mode.

Perform the following steps to display the GENERAL MENU:

1. Display the MAIN MENU (see General Rule #1, paragraph 4.6).
2. Use the cursor keys (◁ and ▷) to place the cursor on GENERAL and press ENTER. The following menu will be displayed:

   GENERAL MENU
   SERIAL # STATUS-MESSAGES

SERIAL # — To display the serial number, SCPI version and software revision level of the instrument, place the cursor on SERIAL # and press ENTER. The following information will be displayed:

Serial #XXXXXX
SCPI version #XXX.X software rev AXX/AYY

where; AXX is the software revision of the main CPU.
AYY is the software revision of the display CPU.

When finished, press ENTER or EXIT to return to the GENERAL MENU.

STATUS MESSAGES — This selection is used to enable or disable the status message mode. When enabled, status messages will be displayed to identify specific operations that are performed. Place the cursor on STATUS-MESSAGES and press ENTER. The following message will be displayed:

STATUS MESSAGES
OFF ON

Place the cursor on the desired state (on or off) and press ENTER. The instrument will return to the GENERAL MENU.

4.7 CARD CONFIG

Various operations to configure the slots of the mainframe are performed from the CARD CONFIG MENU. The menu structure is shown and summarized in Table 4-4.

General rules to use CARD CONFIG MENU:

1. The CARD CONFIG MENU is displayed by placing the instrument in the channel status display state, and then pressing the CARD CONFIGURATION key. If already in the menu structure, the CARD CONFIG MENU can be displayed by pressing and releasing the EXIT key until the CARD CONFIG MENU selections are displayed (see next rule). The CARD CONFIG MENU selections are shown as follows:

   CARD CONFIG MENU
   TYPE #-OF-POLES CARD-PAIR ▶
   ◀ DELAY READ-I/O-CARD

2. The EXIT key causes the display to back up to the previous menu level. Also, keyed-in parameter changes are ignored if an EXIT is performed. When the CARD CONFIG MENU is displayed, pressing EXIT will disable card configuration.
3. The position of the cursor is denoted by the blinking menu selection or parameter. The cursor is moved from one item to the next using the cursor keys (◁ and ▷).
4. A displayed arrow (◀ or ▶) indicates that there is more information or additional menu items to select from. When "▶" is displayed, use the ▷ cursor key to display the additional message(s); and conversely, when "◀" is displayed, use the ◁ cursor key.
5. A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the appropriate key on the keypad. After keying in a number, the cursor will move to the next digit to the right.
6. A parameter change is only executed when the ENTER key is pressed.
7. ENTERing an invalid parameter generates an error and ignores the entry
8. The INFO key can be used anywhere in the menu structure to display helpful information messages concerning operation. To cancel an information message, press EXIT or INFO a second time.

Table 4-4
CARD CONFIG MENU structure

Menu item	Description
TYPE	Set Card Type:
SLOT-1	Assign model number to card in slot 1.
SLOT-2	Assign model number to card in slot 2.
#-OF-POLES	Select # Of Poles:
SLOT-1	Select pole mode for card in slot 1.
SLOT-2	Select pole mode for card in slot 2.
CARD-PAIR	Enable or disable Card Pair.
DELAY	Set Delay For:
SLOT-1	Set delay for card in slot 1.
SLOT-2	Set delay for card in slot 2.
READ-I/O-CARD	Identify I/O Cards.

4.7.1 TYPE

Use the TYPE feature to assign a model number to each non-701X series card installed in the mainframe. This menu selection also allows you to assign a slot to operate as a simulator. By assigning a slot the value 9990, the mainframe will operate as if a 40 channel multiplexer card is installed. If you assign a slot the value 9991, the mainframe will operate as if a 4 x 10 matrix card is installed in that slot. These simulators allow you to develop a test program even though the card is not installed in the mainframe.

The TYPE menu selection displays an assignment message for each slot. These messages were determined by the Model 7001 mainframe during its power-up sequence and is explained in paragraph 4.2.3. In general, the Model 7001 mainframe detects (on power-up) Model 701X series cards that are installed. All other type cards are not detected and thus, the slot must be assigned the appropriate model number by the user. This user assigned model number is "remembered" by the mainframe after it is turned off. However, if the mainframe detects a 701X series card in the slot on the subsequent power-up, it disregards the model number assigned by the user and assigns the model number of the 701X series card to the slot. You can use Table 4-5 to interpret the displayed messages for TYPE.

Each used slot must be assigned the correct model number (either automatically by the mainframe for 701X series cards or manually by the user) in order for the mainframe to operate correctly. The model number assignment automatically determines the settling time for the relays.

Table 4-5
TYPE assignments

Assignment message		Interpretation*
SLOT-1 CARD:	701X**	701X series card installed in slot 1.
SLOT-1 CARD:	NONE	No card installed in slot 1, or slot 1 is not assigned.
SLOT-1 CARD:	7YYY***	Non-701X series model number assigned to slot 1 by the user. The card may or may not be installed in the slot. Also, a different non-701X series card may be installed.
SLOT-1 CARD:	9990	Slot 1 assigned by user to simulate a 40-channel multiplexer. A non-701X card may be installed.
SLOT-1 CARD:	9991	Slot 1 assigned by user to simulate a 4 × 10 matrix. A non-701X card may be installed.
SLOT-2 CARD:	701X**	701X series card installed in slot 2.
SLOT-2 CARD:	NONE	No card installed in slot 2, or an unassigned card installed.
SLOT-2 CARD:	7YYY***	Non-701X series model number assigned to slot 2 by the user. The card may or may not be installed in the slot. Also, a different non-701X series card may be installed.
SLOT-2 CARD:	9990	Slot 2 assigned by user to simulate a quad 1 × 10 multiplexer. A non-701X card may be installed.
SLOT-2 CARD:	9991	Slot 2 assigned by user to simulate a 4 × 10 matrix. A non-701X card may be installed.

* Assumes that power is cycled whenever a card is installed or removed from the mainframe.
** Model 701X series card, such as the Model 7011, 7012 or 7013.
*** Models 7052 though 7402.

Perform the following steps to assign card TYPE.

1. Display the CARD CONFIG MENU (see paragraph 4.7, General rule #1).
2. Place the cursor on TYPE and press ENTER. The following message will be displayed:

```
SET CARD TYPE
SLOT-1      SLOT-2
```

SLOT-1 — To assign slot 1, place the cursor on SLOT-1 and press ENTER. A message indicating the current slot assignment will be displayed. For example, if slot 1 was last assigned as a Model 7052, the following message will be displayed:

```
SLOT-1 CARD: 7052
```

Note: If slot 1 is assigned as a Model 701X series card, you will not be able to change the assignment since that is the card that is actually installed in the slot. Press EXIT to return to the SET CARD TYPE menu.

1. Determine the correct assignment for slot 1 using the following guidelines:
   A. If slot 1 is empty and is not going to be used, assign it as "NONE". This will turn off the front panel channel status display for slot 1 since it is not going to be used.
   B. If using a non-701X series card (Models 7052 through 7402) that is installed in slot 1, assign slot 1 as that model number. For example, if the Model 7062 is installed in slot 1, assign slot 1 as "7062"
   C. If slot 1 is going to be used to simulate a 40 channel mux, assign it as "9990". To simulate a 4 × 10 matrix, assign it as "9991". Note that a non-701X series card left installed will be controlled while using slot 1 as a simulator.
2. Use the cursor keys (◁ and ▷) to display the correct slot assignment. In general, the ◁ cursor key increments the displayed model number while the ▷ cursor key decrements the model number.
3. With the correct slot assignment displayed, press ENTER. The display will return to the SET CARD TYPE menu.

SLOT-2 — To assign slot 2, place the cursor on SLOT-2 and press ENTER. A message indicating the current slot assignment will be displayed. For example, if slot 2 was last assigned as a Model 7052, the following message will be displayed:

```
SLOT-2 CARD: 7052
```

Note: If slot 2 is assigned as a Model 701X series card, you will not be able to change the assignment since that is the card that is actually installed in the slot. Press EXIT to return to the SET CARD TYPE menu.

1. Determine the correct assignment for slot 2 using the following guidelines:
   A. If slot 2 is empty and is not going to be used, assign it as "NONE". This will turn off the front panel channel status display for slot 1 since it is not going to be used.
   B. If using a non-701X series card (Models 7052 through 7402) that is installed in slot 2, assign slot 2 as that model number. For example, if the Model 7062 is installed in slot 2, assign slot 2 as "7062".
   C. If slot 2 is going to be used to simulate a 40 channel mux, assign it as "9990". To simulate a 4 × 10 matrix, assign it as "9991". Note that a non-701X series card left installed will be controlled while using slot 2 as a simulator.
2. Use the cursor keys (◁ and ▷) to display the correct slot assignment. In general, the ◁ cursor key increments the displayed model number while the ▷ cursor key decrements the model number.
3. With the correct slot assignment displayed, press ENTER. The display will return to the SET CARD TYPE menu.

4.7.2 #-OF-POLES

The pole configuration of some switching cards can be altered. For example, the Model 7011 is normally used as 2-pole, 40-channel multiplexer card. However, since Banks A and B can be isolated from Banks C and D, you can configure the card for 4-pole operation. In the 4-pole mode, channels are paired together to form 20 4-pole channels. See the Model 7011 Instruction Manual for details.

Switch cards that have an additional pole mode capability are summarized as follows:

Card	Pole Mode 1-Pole	2-Pole	4-Pole
7011	N/A	40 channels	20 channels
7056	20 channels	10 channels	N/A
7156	20 channels	10 channels	N/A

If you attempt to select an invalid pole mode, a settings conflict error will occur and the entry will be ignored.

Perform the following steps to display the #-OF-POLES menu:

1. Display the CARD CONFIG MENU (see paragraph 4.7, General rule #1).
2. Place the cursor on #-OF-POLES and press ENTER to access the following menu:

```
SELECT # OF POLES
SLOT-1    SLOT-2
```

SLOT-1 — Use this menu item to configure the pole mode for the card in slot 1. Place the cursor on SLOT-1 and press ENTER. The pole mode selections will be displayed. The cursor (flashing menu item) indicates the currently selected pole mode.

```
# OF POLES SLOT-1
1-POLE    2-POLE    4-POLE
```

1. To retain the displayed pole mode, press ENTER or EXIT. The instrument will return to the SELECT # OF POLES menu.
2. To change the displayed pole mode, place the cursor on the desired selection and press ENTER. The instrument will return to the SELECT # OF POLES menu.

SLOT-2 — Use this menu item to configure the pole mode for the card in slot 2. Place the cursor on SLOT-2 and press ENTER. The pole mode selections will be displayed. The cursor (flashing menu item) indicates the currently selected pole mode.

```
# OF POLES SLOT-2
1-POLE    2-POLE    4-POLE
```

1. To retain the displayed pole mode, press ENTER or EXIT. The instrument will return to the SELECT # OF POLES menu.
2. To change the displayed pole mode, place the cursor on the desired selection and press ENTER. The instrument will return to the SELECT # OF POLES menu.

4.7.3 CARD-PAIR

The CARD-PAIR is used to enable (on) or disable (off) the CARD-PAIR feature of the Model 7001. CARD-PAIR can be enabled to pair two similar type switching cards that have the same number of channels. When enabled, corresponding channels of both cards operate together as a pair. For example, closing Channel 4 of slot 1 will also close Channel 4 of slot 2. Conversely, closing Channel 5 of slot 2 will also close Channel 5 of slot 1. This feature is especially useful when performing four-wire scanning.

Perform the following steps to check or change the state of the CARD-PAIR feature:

1. Display the CARD CONFIG MENU (see paragraph 4.7, General rule #1).
2. Place the cursor on CARD-PAIR and press ENTER. The current state of the CARD-PAIR feature will be indicated by the flashing cursor:

```
SET CARD PAIR
OFF    ON
```

3. To retain the displayed CARD-PAIR state, press ENTER or EXIT. The instrument will return to the CARD CONFIG MENU.
4. To select the alternate state, place the cursor on the selection and press ENTER. The instrument will return to the CARD CONFIG MENU.

4.7.4 DELAY

The DELAY feature sets a channel delay for each of the two cards installed in the mainframe. The delay can be set from 00000.001 seconds (1msec) to 99999.999 seconds. This delay is in addition to the internally set relay settling time delay.

This user programmed delay is the time delay between channels during a scan. The first delay period occurs after the first channel(s) closes. In other words, the programmed delay does not occur at the beginning of a scan.

Perform the following steps to set the delay:

1. Display the CARD CONFIG MENU (see paragraph 4.7, General rule #1).
2. Place the cursor on DELAY and press ENTER. The following message will be displayed:

```
SET DELAY FOR:
SLOT-1      SLOT-2
```

SLOT-1 — To set the delay for the card in slot 1, place the cursor on SLOT-1 and press ENTER. The currently set delay will be displayed. For example, if the card in slot 1 is set for a one second delay, the following message will be displayed:

```
(1) DELAY = 00001.000
```

1. To change the delay period, use the cursor keys and the keypad to key in the desired value.
2. With the desired delay displayed, press ENTER. The instrument will return to the SET DELAY FOR: menu.

SLOT-2 — To set the delay for the card in slot 2, place the cursor on SLOT-2 and press ENTER. The currently set delay will be displayed. For example, if the card in slot 2 is set for a 10 second delay, the following message will be displayed:

```
(2) DELAY = 00010.000
```

1. To change the delay period, use the cursor keys and the keypad to key in the desired value.
2. With the desired delay displayed, press ENTER. The instrument will return to the SET DELAY FOR: menu.

4.7.5 READ-I/O-CARD

This menu selection is used to identify if there are any I/O cards installed in the Model 7001.

1. Display the CARD CONFIG MENU (see paragraph 4.7, General Rule #1).
2. Place the cursor on READ-I/O-CARD and press ENTER to display the model number of the I/O card. If no I/O card is installed, the following message will be displayed:

```
No I/O Cards
```

3. Press EXIT to return to the CARD CONFIG MENU.

4.8 SCAN CONFIG

Various operations to configure a scan are performed from the CONFIGURE SCAN menu. The menu structure is shown and summarized in Table 4-6.

Table 4-6
CONFIGURE SCAN menu structure

Menu item	Description
CHAN-CONTROL	Configure Channel Layer:
CHANNEL-SPACING	Select channel spacing:
TIMER	Use a timer to select each channel in the scan.
EXTERNAL	Use an external trigger to select each channel.
GPIB	Use a bus trigger to select each channel.
MANUAL	Use STEP key to select each channel.
TRIGLINK	Use a Trigger Link trigger to select each channel.
ASYNCHRONOUS	Use separate lines for In/Out triggers.
SEMI-SYNCHRONOUS	Use same line for In/Out triggers.
IMMEDIATE	Use to scan channels immediately.
HOLD	Use to hold up the scan in the channel layer.
NUMBER-OF-CHANS	Define number of channels to scan:
USE-SCANLIST-LENGTH	Count = number of channel entries in scan list.
CHAN-COUNT	User defined count:
INFINITE	Repeat channel scanning indefinitely.
ENTER-CHAN-COUNT	Count = user defined value (1 to 9999)
CONTROL	Select trigger control mode:
SOURCE	Enable the Source Bypass.
ACCEPTOR	Disable the Source Bypass.

Table 4-6
CONFIGURE SCAN menu structure

Menu item	Description
SCAN-CONTROL	Configure Scan Layer:
SCAN-SPACING	Select scan spacing:
TIMER	Use the timer to control scan spacing.
EXTERNAL	Use external triggers to control scan spacing.
GPIB	Use bus triggers to control scan spacing.
MANUAL	Use STEP key to control scan spacing.
TRIGLINK	Use Trigger Link triggers to control scan spacing.
IMMEDIATE	Use to pass operation immediately into the channel layer.
HOLD	Use to hold up the scan in the scan layer.
NUMBER-OF-SCANS	Define number of scans to be performed:
INFINITE	Repeat scan indefinitely.
ENTER-SCAN-COUNT	Count = user defined value (1 to 9999).
CONTROL	Select trigger control mode:
SOURCE	Enable Source Bypass.
ACCEPTOR	Disable Source Bypass.
ARM-CONTROL	Configure Arm Layer:
ARM SPACING	Select arm spacing control:
MANUAL	Use STEP key to arm scanner.
IMMEDIATE	Use to arm scanner immediately.
GPIB	Use a bus trigger to arm scanner.
EXTERNAL	Use an external trigger to arm scanner.
TRIGLINK	Use a Trigger Link trigger to arm scanner.
HOLD	Use to hold up the scan in the arm layer.
ARM-COUNT	Define number of times to arm scanner:
INFINITE	Continuously re-arm scanner.
ENTER-ARM-COUNT	User defined count value (1 to 9999).
TRIGGER-CONTROL	Select trigger control mode:
SOURCE	Enable Source Bypass.
ACCEPTOR	Disable Source Bypass.
CHAN-RESTRICTIONS	Define channel restrictions:
SINGLE-CHAN	Enable/disable Single Channel Mode
RESTRICTED-CHANNELS	Designate channels that cannot be closed.

General rules to use CONFIGURE SCAN:

1. The CONFIGURE SCAN menu is displayed by placing the instrument in the channel status display state, and then pressing the SCAN CONFIGURATION key. If already in the menu structure, the CONFIGURE SCAN menu can be displayed by pressing and releasing the EXIT key until the CONFIGURE SCAN menu selections are displayed (see next rule). The CONFIGURE SCAN menu selections are shown as follows:

```
CONFIGURE SCAN
CHAN-CONTROL          SCAN-CONTROL ▶
◀ ARM-CONTROL         CHAN-RESTRICTIONS
```

2. The EXIT key causes the display to back up to the previous menu level. Also, keyed-in parameter changes are ignored if an EXIT is performed. When the CONFIGURE SCAN menu is displayed, pressing EXIT will disable SCAN CONFIGURATION.
3. The position of the cursor is denoted by the blinking menu selection or parameter. The cursor is moved from one item to the next using the cursor keys (◁ and ▷).
4. A displayed arrow (◀ or ▶) indicates that there is more information or additional menu items to select from. When "▶ " is displayed, use the ▷ cursor key to display the additional message(s), and conversely, when "◀ " is displayed, use the ◁ cursor key.
5. A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the appropriate key on the keypad. After keying in a number, the cursor will move to the next digit to the right.
6. A parameter change is only executed when the ENTER key is pressed.
7. ENTERing an invalid parameter generates an error and ignores the entry.
8. The INFO key can be used anywhere in the menu structure to display helpful information messages concerning operation. To cancel an information message, press EXIT or INFO a second time.

4.8.1 CHAN-CONTROL

Channel control is used for the following operations:

- To select the event that controls the time period (CHANNEL SPACING) between channel closures of a scan.
- Designate the NUMBER OF CHANS (channels) in the scan.
- Enable or disable the Source Bypass.

Perform the following steps to display the CHANNEL CONTROL menu:

1. Display the CONFIGURE SCAN menu (see paragraph 4.8, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on CHAN-CONTROL and press ENTER to access the following menu:

```
CHANNEL CONTROL
CHANNEL-SPACING       NUMBER-OF-CHANS ▶
◀ CONTROL
```

CHANNEL SPACING — Use this menu item to select the event that controls the time period between channel closures of the scan. With the CHANNEL CONTROL menu displayed, select this menu item by placing the cursor on CHANNEL-SPACING and pressing ENTER. The following menu will be displayed:

```
SELECT CHAN SPACING
TIMER        EXTERNAL    GPIB     MANUAL ▶
◀ TRIGLINK   IMMEDIATE   HOLD
```

Timer — Use the timer to control channel spacing. The timer is used to set a time interval between channel closures of the scan. The timer can be set for an interval from zero to 99999.999 seconds with 0.001 second (1msec) resolution. The first interval begins after the first channel of the scan closes. Perform the following steps to use the timer:

1. With the SELECT CHAN SPACING menu displayed, place the cursor on TIMER and press ENTER. A message indicating the currently set time interval (in seconds) will be displayed. If, for example the timer is set to 1msec, the following message will be displayed:

```
INTERVAL = 00000.001
```

2. To retain the displayed timer interval, press EXIT or ENTER. The instrument will return to the CHANNEL CONTROL menu.

3. To set a different time interval, use the keypad to key in the value (in seconds) and press ENTER. The instrument will return to the CHANNEL CONTROL menu.

Note: The front panel STEP key (see MANUAL) is active with the timer selected. Each press of the STEP key will select the next channel of the scan. This can be used to quickly step through a scan that has a relatively long timer interval.

External — With this selection, external triggers are used to control channel spacing for the scan. Each trigger stimulus applied to the Model 7001 will open the current channel and close the next channel of the scan. The external trigger is applied to the rear panel "EXTERNAL TRIGGER" BNC connector. In the external trigger mode, the Model 7001 can be used to trigger another instrument. After a channel is closed and settled, a trigger pulse is applied to the rear panel "CHANNEL READY" BNC connector. This trigger pulse can, for example, be used to trigger a DMM to take a reading. External triggering is covered in detail in paragraph 4.10.

Select external triggering from the SELECT CHAN SPACING menu by placing the cursor on EXTERNAL and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

Note: The front panel STEP key (see MANUAL) is active with external triggering selected. Each press of the STEP key will select the next channel of the scan.

GPIB — With this selection, bus triggers are used to control channel spacing for the scan. Each trigger sent over the bus (GET or *TRG) will open the current channel and close the next channel of the scan. See Section 5 for detailed information on bus triggers.

Select bus triggering from the SELECT CHAN SPACING menu by placing the cursor on GPIB and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

Note: The front panel STEP key (see MANUAL) is active with bus triggering selected. Each press of the STEP key will select the next channel of the scan.

Manual — With this selection, the front panel STEP key is used to control channel spacing. Each time the STEP key is pressed, the current channel of the scan will open and the next channel will close.

Select manual triggering from the CHANNEL SPACING menu by placing the cursor on MANUAL and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

Note: The front panel STEP key is active when TIMER, EXTERNAL, GPIB or TRIGGER LINK is selected.

Triglink — With this selection, channel spacing of the scan is controlled by the Trigger Link of the Model 7001. Trigger Link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments. Each trigger stimulus applied to the Model 7001 will open the current channel and close the next channel of the scan. See paragraph 4.11 for details on using the Trigger Link.

Note: The front panel STEP key (see MANUAL) is active with Trigger Link selected. Each press of the STEP key will select the next channel of the scan.

Select the Trigger Link from the SELECT CHAN SPACING menu by placing the cursor on TRIGLINK and pressing ENTER. The following menu will be displayed:

```
SET TRIGGERLINK MODE
ASYNCHRONOUS                SEMI-SYNCHRONOUS
```

ASYNCHRONOUS — The asynchronous trigger link mode is used for trigger configurations that require input and output triggers to be routed on separate lines. Perform the following steps to select the asynchronous mode, and to select the input and output trigger lines for the Model 7001:

1. With the SET TRIGGERLINK MODE menu displayed, place the cursor on ASYNCHRONOUS and press ENTER. The following message will be displayed:

   ```
   SELECT INPUT LINE
   #1 #2 #3 #4 #5 #6
   ```

   The position of the cursor indicates the currently selected input line.

2. To select a trigger input line for the Model 7001, place the cursor on the desired line number and

press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected output line.

3. To select a trigger output line for the Model 7001, place the cursor on a different line number and press ENTER. The instrument will return to the SET TRIGGERLINK MODE menu. Note that you cannot use the same trigger line for both input and output.

SEMI-SYNCHRONOUS — In this mode, the input and output triggers for the Model 7001 are assigned to the same line. Perform the following steps to select the semi-synchronous mode, and to select the trigger line:

1. With the SET TRIGGERLINK MODE menu displayed, place the cursor on SEMI-SYNCHRONOUS and press ENTER. The following message will be displayed:

```
SET SEMI-SYNC LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected trigger line.

2. To select a trigger line for the Model 7001, place the cursor on the desired line number and press ENTER. The instrument will return to the SET TRIGGERLINK MODE menu.

Immediate — With this selection, events (such as the TIMER and EXTERNAL triggers) do not control channel spacing. Once the scan starts, the Model 7001 will step through it as fast as the internal settling time and user programmed delay (see paragraph 4.7) will allow.

Select immediate triggering from the SELECT CHAN SPACING menu by placing the cursor on IMMEDIATE and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

Hold — When HOLD is selected, channel spacing is suppressed. As a result the, scan is stopped and will not continue until HOLD is cancelled by selecting another channel spacing selection. Select trigger hold from the SET CHAN SPACING menu by placing the cursor on HOLD and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

NUMBER OF CHANS — Use this menu item to define the number of channels to be scanned. With the CHANNEL CONTROL menu displayed, select this menu item by placing the cursor on NUMBER-OF-CHANS and pressing ENTER. The following menu will be displayed:

```
NUMBER OF CHANNELS
USE-SCANLIST-LENGTH     CHAN-COUNT
```

Use-scanlist-length — With this selection, the number of channels in the scan will be determined by the number of channels defined in the scan list. For example, if the scan list is made up of channels 1!1, 1!2, 1!3 and 1!4, the number of channels to be scanned will be four. Select scan list length count from the NUMBER OF CHANNELS menu by placing the cursor on USE-SCANLIST-LENGTH and pressing ENTER. The display will return to the CHANNEL CONTROL menu.

Chan-count — With this selection, the user determines the number (count) of channels to scan. The user programmed count can be smaller, equal to, or larger than the number of channels in the scan list. For example, if the scan list is made up of four channels (1!1, 1!2, 1!3 and 1!4), the user can program a count of 12. With this count value, the instrument will repeat the channel scan three times. An advantage of repeating channels (rather than scans) is that delays in the scan layer of operation (SCAN CONTROL) are avoided. The channel spacing delay between all 12 channels are the same.

Select CHAN-COUNT from the NUMBER OF CHANNELS menu by placing the cursor on CHAN-COUNT and pressing ENTER. The following menu will be displayed:

```
CHANNEL COUNT
INFINITE          ENTER-CHAN-COUNT
```

INFINITE — Use this selection to continuously repeat the scan. With the CHANNEL COUNT menu displayed, select this menu item by placing the cursor on INFINITE and pressing ENTER. The display will return to the CHANNEL CONTROL menu.

ENTER-CHAN-COUNT — Use this selection to define the number of channels in the scan. Perform the following steps to define a finite count:

1. With the CHANNEL COUNT menu displayed, place the cursor on ENTER-CHAN-COUNT and press ENTER. A message indicating the current count will be displayed.

   CHANNEL COUNT = 0010

   The above message indicates that the current count is set to 10.

2. To program for a different count (1 to 9999), use the keypad to enter the count value.
3. With the desired count value displayed, press ENTER. The display will return to the CHANNEL CONTROL menu.

CONTROL —Use this menu item to enable or disable the source bypass. The source bypass is used to bypass the channel spacing event on the first pass through the scan. With the CHANNEL CONTROL menu displayed, select this menu item by placing the cursor on CONTROL and pressing ENTER. The following menu will be displayed:

TRIGGER CONTROL
SOURCE ACCEPTOR

Source — With this selection, the source bypass is enabled. The channel spacing event will be bypassed on the first pass through the channel layer. This will allow the first channel in the scan to close without having to wait for the programmed event.

Acceptor — With this selection, the source bypass is disabled.

4.8.2 SCAN CONTROL

Scan control is used for the following operations:

- To select the event that controls scan spacing.
- Designate the NUMBER-OF-SCANS to be performed.
- Enable or disable the Source Bypass.

Perform the following steps to display the SCAN CONTROL menu:

1. Display the CONFIGURE SCAN menu (see paragraph 4.8, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on SCAN-CONTROL and press ENTER to access the following menu:

   SCAN CONTROL
   SCAN-SPACING NUMBER-OF-SCANS ▶
   ◀ CONTROL

SCAN-SPACING — Use this menu item to select the event that controls the time period between scans. With the SCAN CONTROL menu displayed, select this menu item by placing the cursor on SCAN-SPACING and press ENTER. The following menu will be displayed:

SELECT SCAN SPACING
TIMER EXTERNAL GPIB MANUAL ▶
◀ TRIGLINK IMMEDIATE HOLD

Timer — Use the timer feature to control scan spacing. The timer is used to set a time interval between scans. The timer can be set for an interval from zero to 99999.999 seconds with 0.001 second (1msec) resolution. After a scan is triggered to start, the next scan will start at the end of the programmed timer interval. If however, the programmed timer interval is shorter than the time it takes to complete a single scan, the next scan will not start until the previous scan is completed.

Note: The front panel STEP key (see MANUAL) is active with the timer selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the Model 7001 is programmed for another scan; see NUMBER OF SCANS).

Perform the following steps to use the timer:

1. With the SELECT SCAN SPACING menu displayed, place the cursor on TIMER and press ENTER. A message indicating the currently set time interval (in seconds) will be displayed:

   INTERVAL = 00000.001

2. To retain the displayed timer interval, press EXIT or ENTER. The instrument will return to the SELECT SCAN CONTROL menu.

3. To set a different time interval, use the keypad to key in the value (in seconds) and press ENTER. The instrument will return to the SCAN CONTROL menu.

External — With this selection, external triggers are used to control scan spacing. A trigger stimulus applied to the Model 7001 will pass operation into the channel layer. The external trigger is applied to the rear panel "EXTERNAL TRIGGER" BNC connector. See paragraph 4.10 for detailed information on external triggering.

Note: The front panel STEP key (see MANUAL) is active with external triggering selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the Model 7001 is programmed for another scan; see NUMBER OF SCANS).

Select external triggering from the SELECT SCAN SPACING menu by placing the cursor on EXTERNAL and pressing ENTER. The display will return to the SCAN CONTROL menu.

GPIB — With this selection, bus triggers are used to control scan spacing. Operation will pass into the channel layer when a bus trigger (GET or *TRG) is received by the Model 7001. See Section 5 for detailed information on bus triggers.

Note: The front panel STEP key (see MANUAL) is active with bus triggering selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the Model 7001 is programmed for another scan; see NUMBER OF SCANS).

Select bus triggering from the SELECT SCAN SPACING menu by placing the cursor on GPIB and pressing ENTER. The display will return to the SCAN CONTROL menu.

Manual — With this selection, the front panel STEP key is used to control scan spacing. Operation will pass into the channel layer when STEP is pressed.

Note: The front panel STEP key is active when TIMER, EXTERNAL, GPIB or TRIGGER LINK is selected.

Select manual triggering from the SELECT SCAN SPACING menu by placing the cursor on MANUAL and pressing ENTER. The instrument will return to the SCAN CONTROL menu.

Triglink — With this selection, scan spacing is controlled by the Trigger Link of the Model 7001. Trigger Link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments. Operation passes into the channel layer when the Model 7001 receives a trigger over the Trigger Link. See paragraph 4.11 for details on using the Trigger Link.

Note: The front panel STEP key (see MANUAL) is active with the Trigger Link selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the Model 7001 is programmed for another scan; see NUMBER OF SCANS).

Select the Trigger Link from the SELECT SCAN SPACING menu by placing the cursor on TRIGLINK and pressing ENTER. The following menu will be displayed:

```
SELECT INPUT LINE
#1  #2  #3  #4  #5  #6
```

The position of the cursor indicates the currently selected input line.

To select a trigger input line for the Model 7001, place the cursor on the desired line number and press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
#1  #2  #3  #4  #5  #6
```

The position of the cursor indicates the currently selected output line.

To select a trigger output line for the Model 7001, place the cursor on a different line number and press ENTER. Note that you cannot use the same trigger line for both input and output.

Immediate — With IMMEDIATE selected, operation passes immediately into the channel layer. Select immediate scanning from the SELECT SCAN SPACING menu by placing the cursor on IMMEDIATE and pressing ENTER. The instrument will return to the SCAN CONTROL menu.

Hold — When HOLD is selected, scan spacing is suppressed. As a result, operation will not continue until HOLD is cancelled by selecting one of the other scan spacing selections. Select HOLD from the SELECT SCAN SPACING menu by placing the cursor on HOLD and pressing ENTER. The instrument will return to the SCAN CONTROL menu.

NUMBER-OF-SCANS — Use this menu item to define the number of scans to be performed by the Model 7001. With the SCAN CONTROL menu displayed, select this menu item by placing the cursor on NUMBER-OF-SCANS and press ENTER. The following menu will be displayed:

NUMBER OF SCANS
INFINITE ENTER-SCAN-COUNT

Infinite — Use this selection to continuously repeat the scan. Select continuous scanning from the NUMBER OF SCANS menu by placing the cursor on INFINITE and pressing ENTER. The display will return to the SCAN CONTROL menu.

Enter-Scan-Count — With this selection, the user determines the number of scans to perform. You can program the Model 7001 to perform from 1 to 9999 scans. For example, if you enter a scan count of 10, the programmed scan will be performed 10 times. Perform the following steps to enter the scan count:

1. With the NUMBER OF SCANS menu displayed, place the cursor on ENTER-SCAN-COUNT and press ENTER. A message indicating the current scan count will be displayed.

   SCAN COUNT = 0001

   The above scan count indicates that the Model 7001 will perform one scan. A value of "0000" indicates that the scan count is set to infinite.

2. To program for a different count (1 to 9999), use the keypad to enter the count value.
3. With the desired count value displayed, press ENTER. The display will return to the SCAN CONTROL menu.

CONTROL —Use this menu item to enable or disable the source bypass. The source bypass is used to bypass the scan spacing event on the first pass through the scan. With the SCAN CONTORL menu displayed, select this menu item by placing the cursor on CONTROL and pressing ENTER. The following menu will be displayed:

TRIGGER CONTROL
SOURCE ACCEPTOR

Source — With this selection, the source bypass is enabled. The scan spacing event will be bypassed on the first pass through the scan layer. This will allow operation to proceed on into the channel layer without having to wait for the programmed event.

Acceptor — With this selection, the source bypass is disabled.

4.8.3 ARM CONTROL

Arm control is used for the following operations:

- To select the arming event (ARM SPACING) for the scanner.
- Designate the number of times the scanner is to be armed (ARM COUNT)
- Enable or disable the Source Bypass.

Perform the following steps to display the ARM CONTROL menu:

1. Display the CONFIGURE SCAN menu (see paragraph 4.8, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on ARM CONTROL and press ENTER to access the following menu:

   SETUP ARM CONTROL
   ARM-SPACING ARM-COUNT ▶
   ◀ TRIGGER-CONTROL

ARM-SPACING — This menu item is used to select the event that controls the arm spacing. To select this menu item, place the cursor on ARM-SPACING and press ENTER. The following menu will be displayed:

ARM SPACING
MANUAL IMMEDIATE GPIB ▶
◀ EXTERNAL TRIGLINK HOLD

Manual — With this selection, the front panel STEP key is used to control arm spacing. Operation will pass into the scan layer when the STEP key is pressed.

Note: The front panel STEP key is active when TIMER, EXTERNAL, GPIB or TRIGGER LINK is selected.

To select manual triggering (STEP key) from the SELECT ARM SPACING menu, place the cursor on MANUAL and press ENTER. The instrument will return to the SETUP ARM CONTROL menu.

Immediate — With this selection, operation will pass immediately into the scan layer.

Select immediate triggering from the SELECT ARM SPACING menu by placing the cursor on IMMEDIATE and pressing ENTER. The instrument will return to the SETUP ARM CONTROL menu.

GPIB — With this selection, bus triggers are used to control arm spacing. Operation will pass immediately into the scan layer when a bus trigger (GET or *TRG) is received by the Model 7001. See Section 5 for detailed information on bus triggers.

Note: The front panel STEP key (see MANUAL) is active with bus triggering selected. Pressing the STEP key will pass operation into the scan layer.

To select bus triggering from the SELECT ARM SPACING menu, place the cursor on GPIB and press ENTER. The display will return to the SETUP ARM CONTROL menu.

External — With this selection, external triggers are used to control arm spacing. A trigger stimulus applied to the Model 7001 will pass operation into the scan layer. The external trigger is applied to the rear panel "EXTERNAL TRIGGER" BNC connector. See paragraph 4.10 for detailed information on external triggering.

Note: The front panel STEP key (see MANUAL) is active with external triggering selected. Pressing the STEP key will pass operation into the scan layer.

To select external triggering from the SELECT ARM SPACING menu, place the cursor on EXTERNAL and press ENTER. The instrument will return to the SETUP ARM CONTROL menu.

Triglink — With this selection, arm spacing is controlled by the Trigger Link of the Model 7001. Trigger Link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments. Operation passes into the scan layer when the Model 7001 receives a trigger over the Trigger Link. See paragraph 4.11 for details on using the Trigger Link.

Note: The front panel STEP key (see MANUAL) is active with the Trigger Link selected. Pressing the STEP key will pass operation into the scan layer.

To select the Trigger Link from the SELECT ARM SPACING menu, place the cursor on TRIGLINK and press ENTER. The following menu will be displayed:

```
SELECT INPUT LINE
#1  #2  #3  #4  #5  #6
```

The position of the cursor indicates the currently selected input line.

To select a trigger input line for the Model 7001, place the cursor on the desired line number and press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
#1  #2  #3  #4  #5  #6
```

The position of the cursor indicates the currently selected output line.

To select a trigger output line for the Model 7001, place the cursor on a different line number and press ENTER. Note that you cannot use the same trigger line for both input and output.

Hold — When HOLD is selected, arm spacing is suppressed. As a result, operation will not pass into the scan layer until HOLD is cancelled by selecting one of the other arm spacing selections. Select HOLD from the SELECT ARM SPACING menu by placing the cursor on HOLD and pressing ENTER. The instrument will return to the SETUP ARM CONTROL menu.

ARM-COUNT — This menu item is used to define the number of times operation will return to the arm layer. With the SETUP ARM CONTROL menu displayed, select this menu item by placing the cursor on ARM-COUNT and press ENTER. The following menu will be displayed:

ARM COUNT
INFINITE ENTER-ARM-COUNT

Infinite — Use this selection to continuously return operation to the arm layer. Select continuous arming from the ARM COUNT menu by placing the cursor on INFINITE and pressing ENTER. The display will return to the SETUP ARM CONTROL menu.

Enter-Arm-Count — With this selection, the user determines the number of times operation returns to the arm layer. You can program the Model 7001 to arm up to 9999 times. Perform the following steps to enter the arm count:

1. With the ARM COUNT menu displayed, place the cursor on ENTER-ARM-COUNT and press ENTER. A message indicating the current arm count will be displayed.

   ARM COUNT = 0001

   The above arm count indicates that the scanner will arm one time. An arm count of "0000" indicates that infinite is selected.

2. To program for a different count (1 to 9999), use the keypad to enter the count value.
3. With the desired count value displayed, press ENTER. The display will return to the SETUP ARM CONTROL menu.

TRIGGER CONTROL — Use this menu item to enable or disable the source bypass. The source bypass is used to bypass the arm spacing event on the first pass through the scan. With the SETUP ARM CONTROL menu displayed, select this menu item by placing the cursor on TRIGGER-CONTROL and pressing ENTER. The following menu will be displayed:

TRIGGER CONTROL
SOURCE ACCEPTOR

Source — With this selection, the source bypass is enabled. The arm spacing event will be bypassed on the first pass through the arm layer. This will allow operation to proceed on into the scan layer without having to wait for the programmed event.

Acceptor — With this selection, the source bypass is disabled.

4.8.4 Channel restrictions

The Model 7001 can be programmed for the following channel restrictions:

- The user can enable the SINGLE CHAN (channel) mode to prevent more than one channel from being closed at the same time.
- The user can define a list of RESTRICTED CHANNELS. Channels in this list cannot be closed.

Perform the following steps to display the CHANNEL RESTRICTIONS menu:

1. Display the CONFIGURE SCAN menu (see paragraph 4.8, General rule #1).
2. Use the cursor keys (◁ and ▷) to place the cursor on CHAN-RESTRICTIONS, and press ENTER to access the following menu:

   CHANNEL RESTRICTIONS
   SINGLE-CHAN RESTRICTED-CHANNELS

SINGLE-CHAN — Use this menu item to enable or disable the single channel mode. With the single channel mode enabled (ON), only one channel can be closed. Two or more channels cannot be closed at the same time.

Perform the following steps to enable or disable the single channel mode:

1. With the CHANNEL RESTRICTIONS menu displayed, place the cursor on SINGLE-CHAN and press ENTER. The following message will be displayed:

   SINGLE CHANNEL MODE
   OFF ON

   Cursor position indicates the current status of the single channel mode.

2. Place the cursor on the desired state (ON or OFF) and press ENTER. The display will return to the CHANNEL RESTRICTIONS menu.

Operating Notes:

1. For Single Channel, when more than one channel is assigned to a channel list, only the lowest numbered channel in the lowest numbered slot will close when CLOSE is pressed. For example, assume the following channel list is defined:

   SELECT CHANNELS 2!1, 2!2, 1!5
   When CLOSE is pressed, Channel 1!5 will close.

2. When the single channel mode is enabled, all stored channel patterns are cleared. For example, if closed Channels 1!1 and 1!2 are stored at memory location #001 (M1), enabling single channel will clear that memory location.
3. The single channel mode cannot be enabled if two or more channels are currently closed.

RESTRICTED-CHANNELS — Used to designate channels that cannot be closed from either the front or over the bus. This is primarily used as a safety feature to prevent the inadvertent closing of a channel(s) that could cause damage to instrumentation or DUT (i.e. shorting a power supply in a matrix test system).

Perform the following steps to define the restricted channels:

1. With the CHANNEL RESTRICTIONS menu displayed, place the cursor on RESTRICTED-CHANNELS and press ENTER. The following message will be displayed:

   RESTRICTED CHANNELS
   SELECT CHANNELS

2. Use the keypad to enter the channel list and press EXIT.

4.9 Digital I/O port

The Model 7001 has a built-in digital I/O port that can be used to control external digital circuitry. The port provides four output channels and one input channel.

4.9.1 Digital output channels

The Model 7001 has four digital output channels. Each open collector output can be set high (+5V) or low (0V) and will sink up to 100mA.

The front panel MENU feature sets the level of the digital output channels. The DIGITAL I/O MENU sets the output status (on or off) of each output channel, and the polarity (active-high or active-low) of each channel. With polarity active-high, an "on" output channel is set to +5V. Conversely, with polarity active-low, an "on" output channel is set to 0V. See paragraph 4.6 for details on setting the output port.

A user supplied voltage level (up to 30V) can be used instead of the internal 5V (TTL) level. To use a different level, simply apply the voltage to pin 3 of the I/O receptacle (see Figure 4-9).

4.9.2 Digital input channel

The Model 7001 has one digital input channel that is used to read a TTL input level. A TTL high on the input will be read as "ON".

The front panel MENU feature reads the level of the digital input channel.

4.9.3 I/O port connections

The DIGITAL I/O port is located on the rear panel as shown in Figure 4-9. This drawing also provides the pin identification for the 8-pin micro DIN female receptacle. Since the DIGITAL I/O receptacle is the same as the TRIGGER LINK receptacle, you can use a trigger link cable (Keithley Model 8501) to make connections.

By cutting a trigger link cable in two, it is possible to hard-wire the unterminated end directly to an external digital circuit.

By hard-wiring an external circuit to an 8-pin micro DIN female receptacle (see rear panel; Keithley Model 8501), you can use one complete Trigger Link cable for the digital I/O connections. Figure 4-10 provides pin identification for the Trigger Link cable when it is used for the DIGITAL I/O port.

CAUTION

Trigger Link and the Digital I/O port use the same type of connector. To prevent possible damage, do not connect the Digital I/O to the Trigger Link. Also, when connecting an external circuit to the Digital I/O, take care to not accidentally connect it to the Trigger Link.

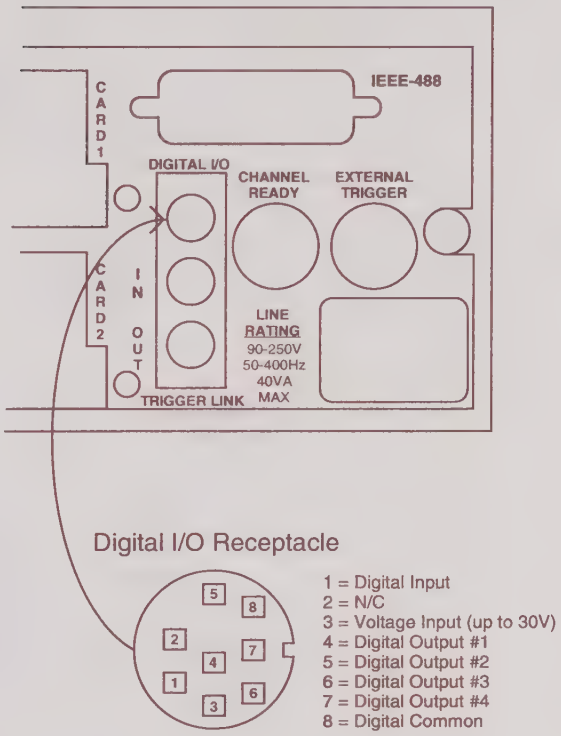


Figure 4-9
Digital I/O port

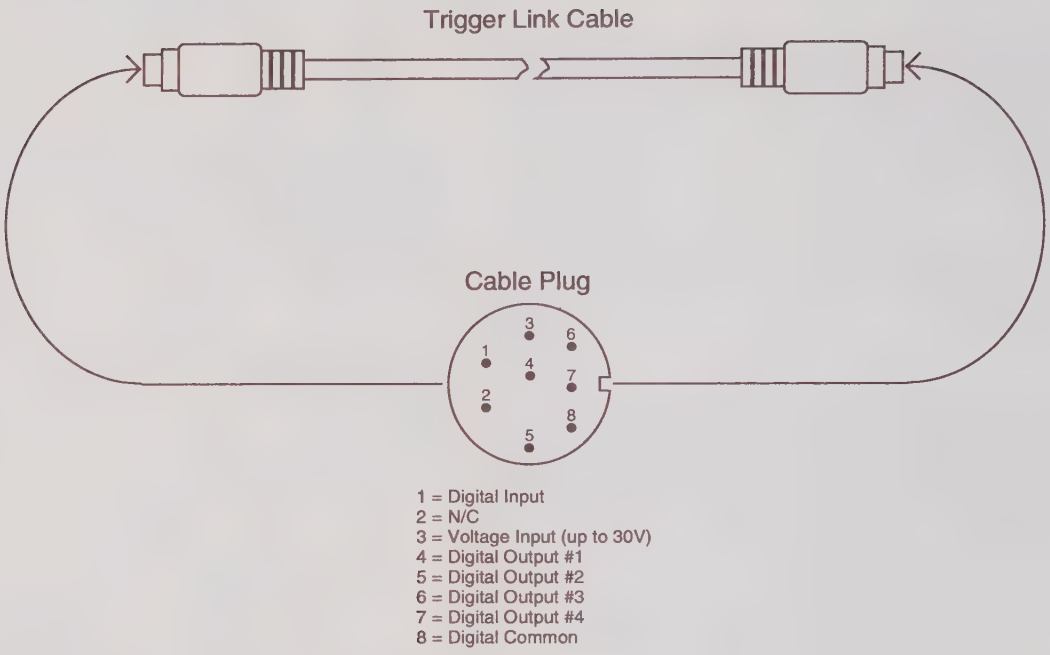


Figure 4-10
Digital I/O connections using trigger link cable

4.10 External triggering

The Model 7001 has BNC connectors on the rear panel (see Figure 4-11) associated with external triggering. The EXTERNAL TRIGGER input jack allows the Model 7001 to be triggered by other instruments and the CHANNEL READY output jack allows the Model 7001 to trigger other instruments.

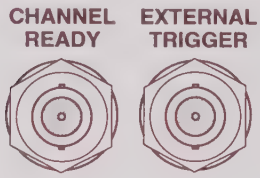


Figure 4-11
External triggering connectors (BNC)

4.10.1 External trigger

The EXTERNAL TRIGGER input jack requires a falling-edge, TTL-compatible pulse with the specifications shown in Figure 4-12.

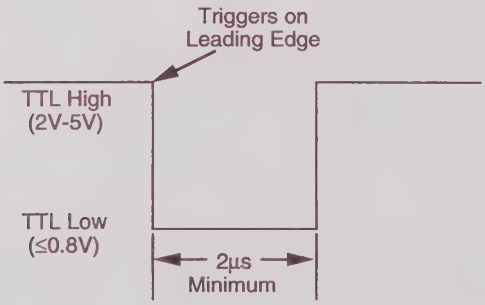


Figure 4-12
External trigger and asynchronous Trigger Link Input pulse specifications

In general, external triggers can be used as events to control scan operation. In order for the Model 7001 to respond to external triggers, the appropriate layers of scan operation must be configured for it. Paragraph 4.8 explains how to program the three layers of the scan.

4.10.2 Channel ready

The CHANNEL READY output jack provides a TTL-compatible output pulse that can be used to trigger other instrumentation. The specifications for this trigger pulse are shown in Figure 4-13.

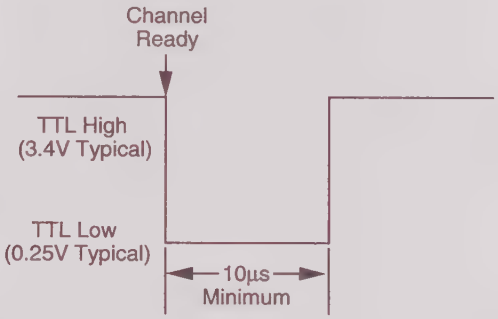


Figure 4-13
Channel ready and asynchronous Trigger Link Output pulse specifications

Typically, you would want the Model 7001 to output a trigger after each channel closes and settles (settling time includes the internally set relay settle time and the user programmed DELAY period; see paragraph 4.7). An output trigger will occur after each scanned channel as long as channel spacing is set to external. See paragraph 4.8.1 for details on programming the channel layer.

The Model 7001 can also output a trigger while in the scan and/or arm layers of operation. Figure 4-8 shows where these triggers occur in the trigger model. An output trigger will occur on each return path through the scan layer if the scan layer Source Bypass is enabled (Control = Source) and Scan Spacing is programmed for External. An output trigger will occur on each return path through the arm layer if the arm layer Source Bypass is enabled (Control = Source) and Arm Spacing is programmed for External. See paragraph 4.8.2 and 4.8.3 for programming the scan and arm layer.

4.10.3 External triggering example

In a typical test system, you may want to close a channel and then measure the DUT connected to that channel with a DMM such as the Keithley Model 196. Such a test system is shown in Figure 4-14 which uses a Model 7011 multiplexer card to switch 10 DUTs to the DMM.

The external trigger connections for this test system are shown in Figure 4-15. Channel Ready (output) of the Model 7001 is connected to External Trigger Input of the Model 196, and External Trigger (input) of the Model 7001 is connected to Voltmeter Complete Output of the Model 196.

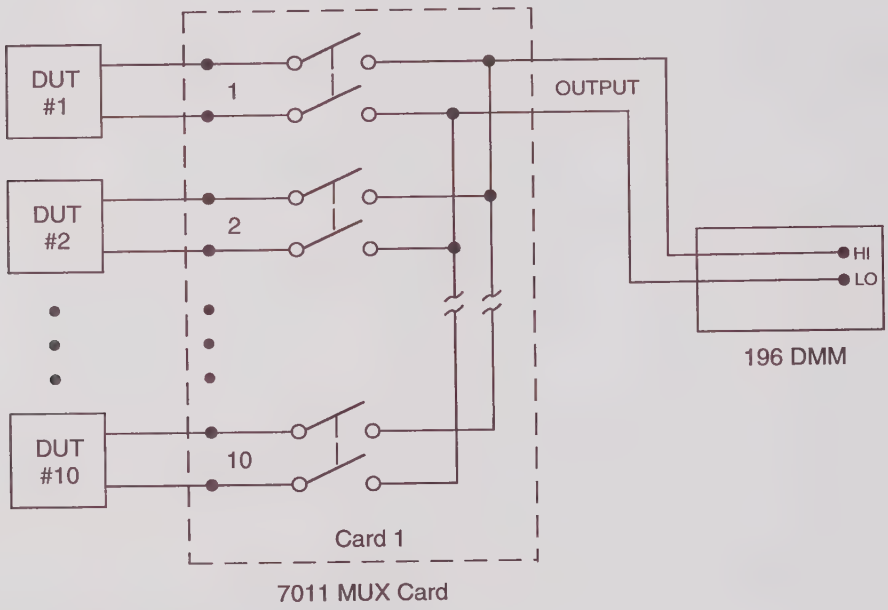


Figure 4-14
DUT test system

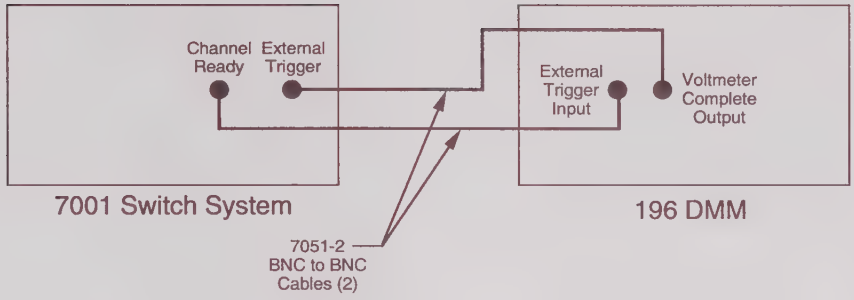


Figure 4-15
External trigger connectors

For this test system, the Model 196 is configured for external triggering and the scan is configured as follows:

Scan List = 1!1-1!10,

Arm Layer:
- Arm Spacing = Immediate*
- Arm Count = 1*
- Arm Trigger Control = Acceptor*

Scan Layer:
- Scan Spacing = Immediate*
- Number of Scans = 1
- Scan Trigger Control = Acceptor*

Channel Layer:
- Channel Spacing = External
- Number of Channels = Use Scan list Length*
- Channel Trigger Control = Source*

* Indicates that the setting is the RESET (and factory) default condition.

Notice that Channel Trigger Control is set for Source. With this selection, scan operation will initially bypass the need for an external trigger to close the first channel. Since arm spacing and scan spacing are set for Immediate, the scan will start immediately as soon as the scanner is taken out of the idle state by pressing the STEP key.

When the front panel STEP key is pressed, the scanner will arm and close the first channel. After Channel 1!1 settles (channel ready), a trigger is sent from Channel Ready of the Model 7001 to External Trigger Input of the Model 196 to trigger a measurement of DUT #1. After the Model 196 completes the measurement, it will output a trigger from Voltmeter Complete Output to External Trigger input of the Model 7001, which closes the next channel. After Channel 1!2 settles, a trigger is sent to the Model 196 to trigger a measurement of DUT #2. When the measurement is completed, a trigger is sent to the Model 7001 to close the next channel. After this channel settles, a trigger is sent to the DMM to trigger a measurement. This process continues until all 10 channels are scanned and measured. The data store of the Model 196 could be used to store the measurements as they occur.

4.11 Trigger Link

The Model 7001 has enhanced external triggering capabilities using the Trigger Link. The Trigger Link has six lines allowing up to six instruments to be controlled over this trigger bus. The micro 8-pin DIN sockets used for the Trigger Link are shown in Figure 4-16.

Figure 4-16
Trigger link connectors

NOTE

The two rear panel Trigger Link connectors are actually connected in parallel to each other. Thus, the IN and OUT labels are a misnomer. It doesn't matter which connector you use when connecting the Trigger Link to another instrument.

CAUTION

Trigger Link and the Digital I/O port use the same type of connector. To prevent possible damage, do not connect the Digital I/O to the Trigger Link. Also, when connecting an external circuit to the Digital I/O, take care to not accidentally connect it to the Trigger Link.

In general, Trigger Link input triggers to the Model 7001 are used to control scan operation. In order for the Model 7001 to respond to Trigger Link compatible triggers, the appropriate layers of the scan must be programmed for it. For example, if you want Trigger Link input triggers to control the channel scan process, you must program Channel Spacing for TRIGLINK trigger events. Typically, a Trigger Link output trigger from the Model 7001 would be used to trigger another instrument to measure the currently selected channel.

There are two modes of operation for Trigger Link; asynchronous and semi-synchronous. In the asynchronous mode, separate lines are used for input and output triggers, and in semi-synchronous mode, the same line is used for both input and output triggers.

4.11.1 Asynchronous operation

In the asynchronous operating mode, Trigger Link functions fundamentally in the same manner as External Triggering (see paragraph 4.10). Like External Triggering, the asynchronous mode uses separate lines for input and output triggers. Also, the asynchronous mode uses the same TTL-compatible pulses as External Triggering. The input trigger specifications for asynchronous mode are shown in Figure 4-12 and the output trigger specifications are shown in Figure 4-13.

For typical asynchronous Trigger Link operation, the channel layer of the scan is configured with Channel Spacing set to TRIGLINK and Triggerlink Mode set to Asynchronous. You must also select input and output lines for the channel layer. Input and output triggers can be set to any of the six lines, but they cannot use the same line. For example, if you select line #1 for input triggers, then output triggers must use one of the other five lines (#2 through #6). During operation in the channel layer, each Trigger Link input trigger will close a channel in the scan. After the relay settles, and the user programmed DELAY (see paragraph 4.7) times out, the Model 7001 will output a Trigger Link trigger (typically to a DMM to make a measurement). The channel layer is configured using the CONFIGURE SCAN menu (see paragraph 4.8.1).

The scan layer and/or arm layer can also be programmed for TRIGGER LINK; Scan Spacing is set to TRIGLINK, and ARM SPACING is set to TRIGLINK. When using Trigger Link in these layers, you must also

select input and output lines as you did in the channel layer. Keep in mind that you can use the same lines in the scan and arm layers that you selected in the channel layer.

Asynchronous Trigger Link example #1

In a typical test system, you may want to close a channel and then measure the DUT connected to that channel with a meter. Such a test system is shown in Figure 4-17 which uses a Model 7011 multiplexer card to switch 10 DUTs to a meter that is equipped with Trigger Link.

The Trigger Link connections for this test system are shown in Figure 4-18. Trigger Link of the Model 7001 is connected to Trigger Link of the meter. Notice that only one Trigger Link cable is needed.

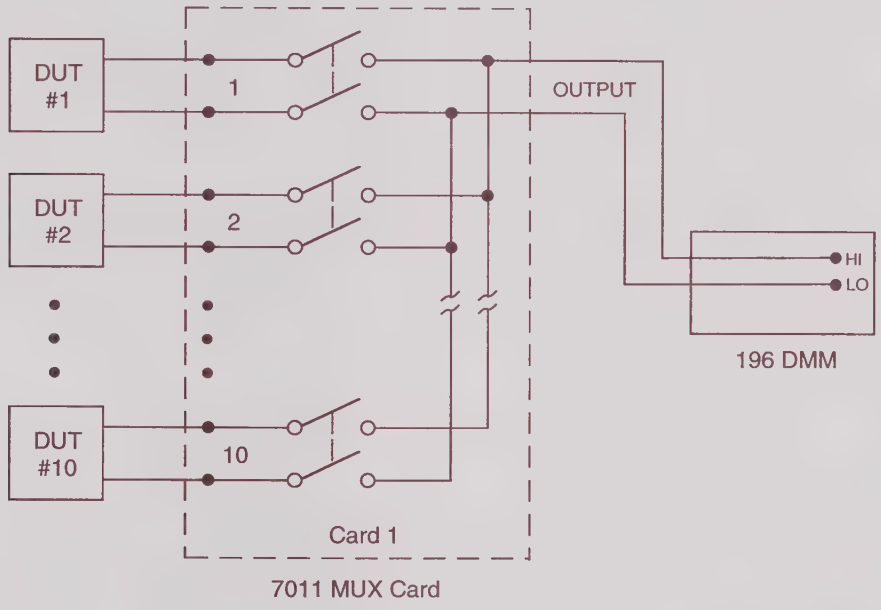


Figure 4-17
DUT test system

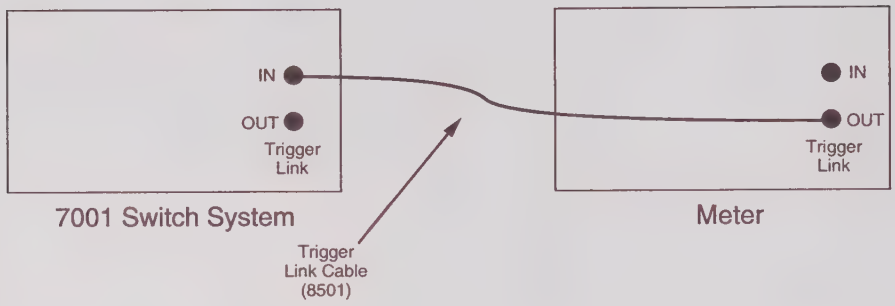


Figure 4-18
Trigger Link connections (asynchronous example #1)

For this example, the Model 7001 and the meter are configured as follows:

Model 7001:

Scan List = 1!1-1!10,

Arm Layer:
Arm Spacing = Immediate*
Arm Count = 1*
Arm Trigger Control = Acceptor*

Scan Layer:
Scan Spacing = Immediate*
Number of Scans = 1
Scan Trigger Control = Acceptor*

Channel Layer:
Channel Spacing = TrigLink
Trigger Link Mode = Asynchronous
Input Line = #2
Output Line = #1
Channel Trigger Control = Source*
Number of Channels = Use Scanlist Length*

* Indicates that the setting is the RESET (and factory) default condition.

Meter:

Arm Layer:
Arm Source = Immediate
Arm Count = 1
Arm Trigger Control = Acceptor

Scan Layer:
Scan Source = Immediate
Scan Count = 1
Scan Trigger Control = Acceptor

Measure Layer:
Measure Source = TrigLink
Trigger Link Mode = Asynchronous
Input Line = #1
Output Line = #2
Measure Trigger Control = Acceptor
Measure Count = 10

Notice that Channel Trigger Control of the Model 7001 is set for Source. With this selection, scan operation will initially bypass the need for a Trigger Link trigger to close the first channel. Since arm spacing and scan spacing are set for Immediate, the scan will start immediately as soon as the scanner is taken out of the idle state by pressing the STEP key (assuming the meter is also out of the idle state).

To run the test simply press TRIG on the meter to take it out of the idle state and then press STEP on the Model 7001. The following explanation on operation is referenced to the operation model shown in Figure 4-19.

Ⓐ Pressing TRIG takes the meter out of the idle state and places meter operation at point A in the flowchart where it is waiting for a Trigger Link trigger. Note that since both the arm layer and scan layer are programmed for Immediate Source, operation immediately drops down to the measure layer at point A.

Ⓑ Pressing STEP takes the Model 7001 out of the idle state and places operation at point B in the flowchart. Since both the arm and scanner layers are programmed for Immediate Spacing, operation drops down to the channel layer at point B.

Ⓒ Since Channel Trigger Control is set for Source, the scan will not wait at point B for a trigger. Instead it will bypass "Wait for Trigger Link Trigger" and close the first channel (point C). Note that the Bypass is only in effect on the first pass through the model.

Ⓓ After the relay settles, the Model 7001 will output a Trigger Link trigger pulse (point D). Since the instrument is programmed to scan 10 channels, operation will loop back up to point B where it will wait for an input trigger. Note that Bypass is no longer in effect.

Ⓔ & Ⓕ Remember that meter operation is at point A waiting for a trigger. The output trigger from the Model 7001 triggers the meter to measure DUT #1 (point E). After the measurement is completed, the meter will output a trigger pulse (point F) and then loop back to point A where it will wait for another input trigger.

The trigger applied to the Model 7001 from the meter closes the next channel in the scan which in turn triggers the meter to measure the next DUT. This process continues until all 10 channels are scanned and measured.

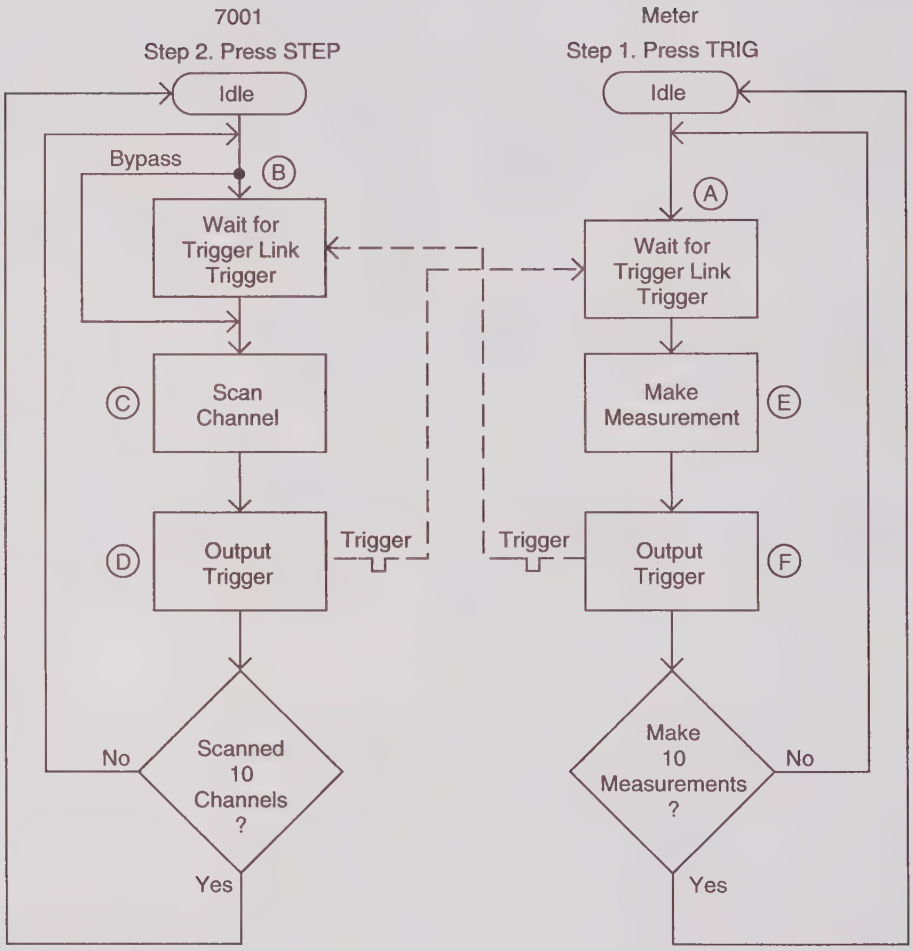


Figure 4-19
Operation model for asynchronous Trigger Link example #1

External Triggering and Trigger Link—As previously mentioned, the trigger pulses for the asynchronous Trigger Link are identical to the trigger pulses used for External Triggering. The only thing that prevents them from being used together are connection incompatibilities. Trigger Link uses micro 8-pin DIN connectors while External Triggering uses BNC connectors.

This connection problem can be resolved by using the Model 8502 Trigger Link Adapter. The adapter has two micro 8-pin DIN connectors and six BNC connectors. The DIN connectors connect directly to a Trigger Link connector on the Model 7001 using a trigger link cable. The BNC connectors mate directly to the External Triggering BNC connectors on other instruments using standard male BNC to BNC cables.

Figure 4-20 shows how a Keithley Model 196 can be connected to the Trigger Link of the Model 7001 using the adapter. With this adapter, the Model 196 could be substituted for the meter with Trigger Link in the previous example (Asynchronous Trigger Link Example #1). With the Model 196 set for external triggering, the test would start when STEP on the Model 7001 is pressed.

Asynchronous Trigger Link example #2

In this example, the test system (Figure 4-21) includes a Model 196 DMM to measure each DUT at two different bias levels that are provided by the Model 230 voltage source. With the source set to the first voltage level, the 10 channels will be scanned and measured. The source will then be set to the second voltage level and the 10 channels will again be scanned and measured.

Since this example uses instruments that do not have Trigger Link (Model 196 and 230), the Model 8502 Trigger Link Adapter is required. Connections are shown in Figure 4-22.

For this example, the Models 196 and 230 are programmed for External Triggering and the Model 230 is set to source the first voltage level. The Model 7001 is configured as follows:

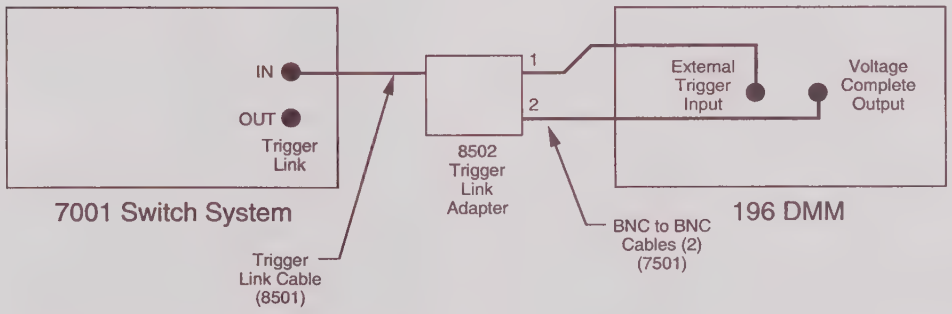


Figure 4-20
Connections using Trigger Link adapter

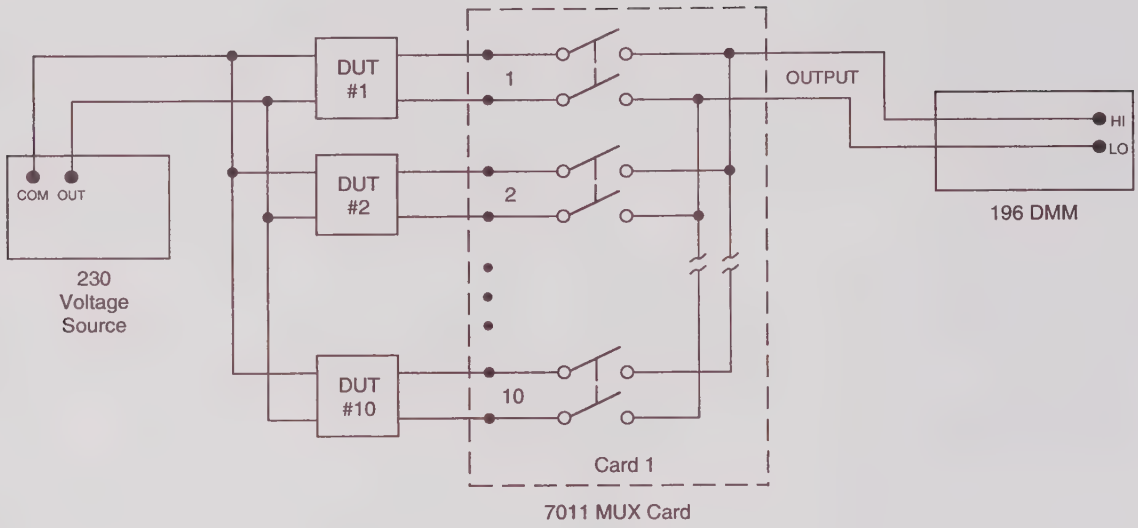


Figure 4-21
DUT test system (asynchronous example #2)

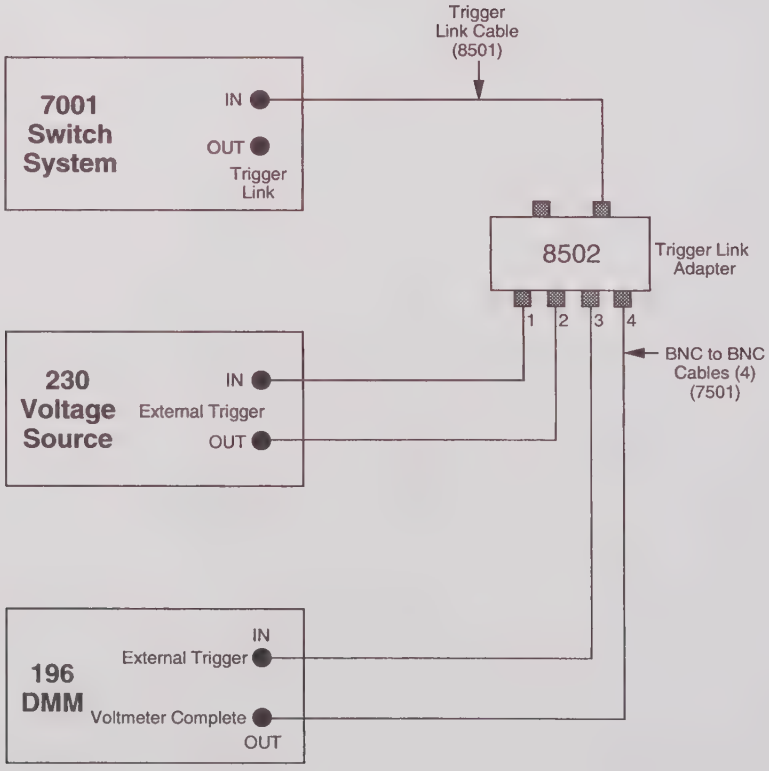


Figure 4-22
Trigger Link connections (asynchronous example #2)

Model 7001:

Scan List = 1!1-1!10,

Arm Layer:
Arm Spacing = Immediate*
Arm Trigger Control = Acceptor*
Arm Count = 1*

Scan Layer:
Scan Spacing = TrigLink
Input Line = # 2
Output Line = #1
Scan Trigger Control = Source
Number of Scans = 2

Channel Layer:
Channel Spacing = TrigLink
Trigger Link Mode = Asynchronous
Input Line = #4
Output Line = #3
Channel Trigger Control = Source*
Number of Channels = Use Scanlist Length*

* Indicates that the setting is the RESET (and factory) default condition.

To run the test, simple press STEP on the Model 7001. The following explanation on operation is referenced to the operation model shown in Figure 4-23.

Ⓐ Pressing STEP takes the Model 7001 out of the idle state and places operation at point A in the flowchart. Since the arm layer is programmed for Immediate Spacing, operation drops down to the scan layer at point A.

Ⓑ Since Scan Trigger Control is set for Source, the scan will not wait at point A for a trigger. Instead, it will bypass "Wait for Trigger Link Trigger" and proceed to point B. Note that this Bypass is only in effect on the first pass through the model.

Ⓒ Since Channel Trigger Control is also set for Source, the scan will not wait at point B for a trigger. Instead it will bypass "Wait for Trigger Link Trigger" and close the first channel (point C). Note that this Bypass is only in effect on the first pass through the model.

Ⓓ After the relay settles, the Model 7001 will output a Trigger Link trigger pulse (point D). Since the instrument is programmed to scan 10 channels, operation will loop back up to point B where it will wait for an input trigger. Note that Bypass is no longer in effect

Ⓔ The trigger pulse from the Model 7001 will trigger the Model 196 to make a measurement of DUT #1. After the measurement is completed, the DMM will output a trigger pulse (point E).

The trigger applied to the Model 7001 from the DMM closes the next channel in the scan which in turn triggers the meter to measure the next DUT. This process continues until all 10 channels are scanned and measured.

Ⓕ After the last channel is scanned and measured, operation proceeds to point F where the Model 7001 outputs a trigger pulse. Since the Model 7001 is programmed to perform two scans, its operation will loop back up to point A where it will wait for an input trigger. Note that Bypass is no longer in effect.

Ⓖ The trigger pulse from the Model 7001 triggers the Model 230 to output the next programmed voltage level. After the voltage level is set, the Model 230 will output a trigger pulse (point G).

The trigger pulse applied to the Model 7001 from the Model 230 places operation at point B. The Bypass is again in effect because this is the beginning of a new scan. This allows operation to drop down to point C where the first channel will again be closed and eventually measured. As previously explained all ten channels are scanned and measured.

After the last channel of the second scan is closed and measured, the Model 7001 returns to the idle state.

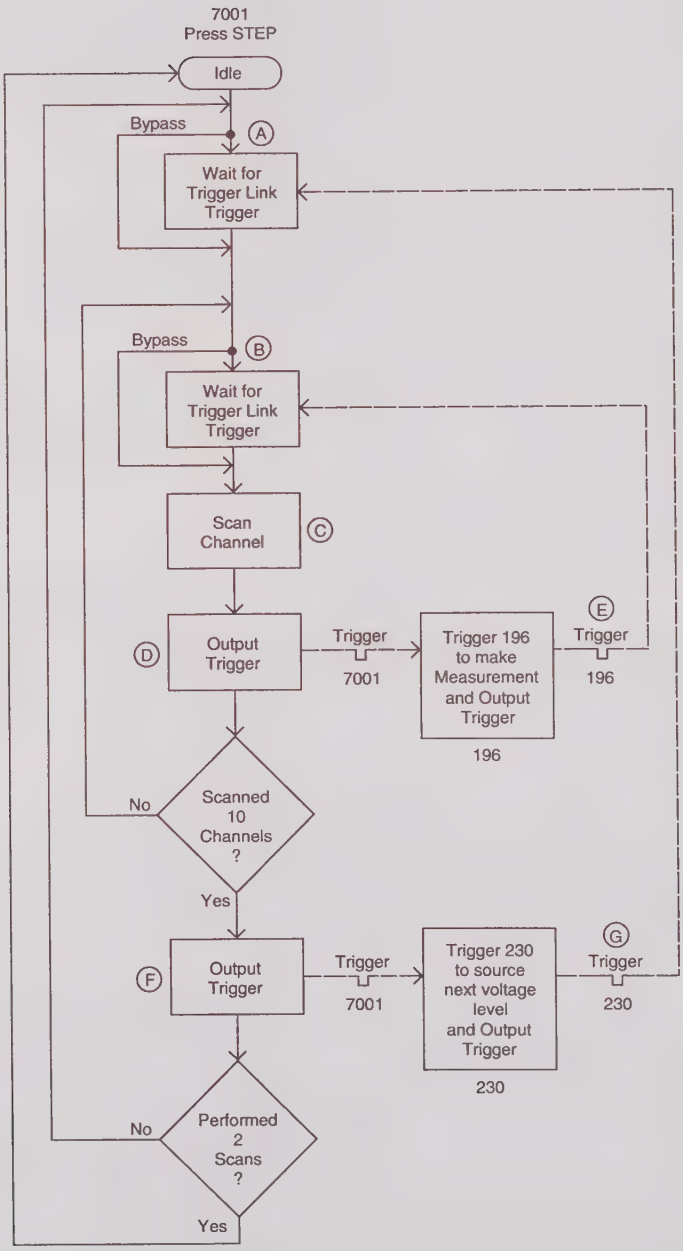


Figure 4-23
Operation model for asynchronous Trigger Link example #2

4.11.2 Semi-synchronous operation

In the Semi-Synchronous Trigger Link mode all triggering (input and output) in the test system is controlled by a single line. When the normally high (+5V) trigger line is pulled low (0V), a trigger occurs on the negative-going edge. When the trigger line is released, a trigger occurs on the positive-going edge (see Figure 4-24). The advantage of this single line trigger is that as long as one of the instruments in the system holds the line low, the trigger is suppressed. In other words, the trigger will not occur until all instruments in the system are ready.

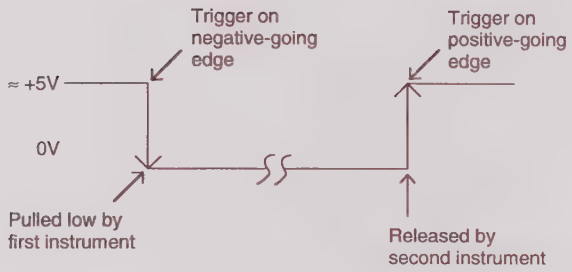


Figure 4-24
Semi-synchronous trigger link specifications

For example, assume that a meter (equipped with Trigger Link) is connected to two Model 7001s for semi-synchronous operation as shown in Figure 4-25. All three instruments are programmed to use trigger line #1. The two Model 7001s have relay settling times of 10msec and 50msec respectively.

Assume that the meter initially performs a measurement. After the reading is done, the meter will drive the trigger line low. The negative-going edge will trigger both Model 7001s to close a channel. While the Model 7001s are in the process of closing a channel, they will hold the trigger line low. Ten milliseconds after switch closure, the first Model 7001 will release the trigger line. However, the second Model 7001 will continue to hold the line low since it is not finished. Fifty milliseconds after switch closure, the second Model 7001 will release the trigger line. The positive-going edge will trigger the meter to perform a measurement and subsequently pull the trigger line back down to close the next channels. This process continues until all channels are scanned and measured.

Semi-synchronous trigger link example

This example uses the same test system (Figure 4-17) that was used for the Asynchronous Trigger Link Example #1. However, triggering will be done using the Semi-Synchronous mode. Trigger Link connections are shown in Figure 4-26.

The two instruments are configured as follows:

Model 7001:

Scan List = 1!1-1!10,

Arm Layer:
- Arm Spacing = Immediate*
- Arm Count = 1*
- Arm Trigger Control = Acceptor*

Scan Layer:
- Scan Spacing = Immediate*
- Number of Scans = 1
- Scan Trigger Control = Acceptor*

Channel Layer:
- Channel Spacing = TrigLink
- Trigger Link Mode = Semi-Synchronous
- Semi-Sync Line = #1
- Trigger Control = Source*
- Number of Channels = Use Scanlist Length*

* Indicates that the setting is the RESET (and factory) default condition

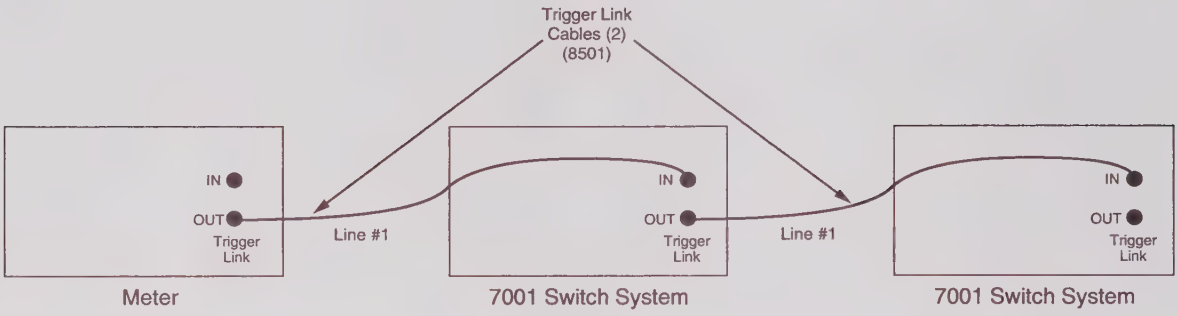


Figure 4-25
Typical semi-synchronous mode connections

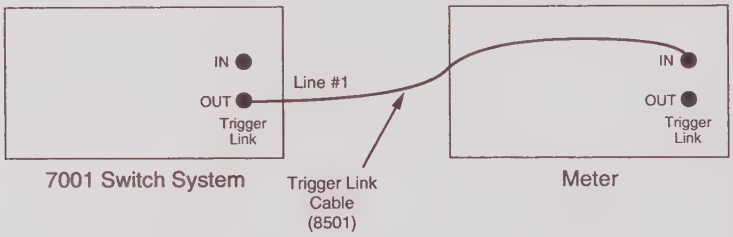


Figure 4-26
Trigger Link connections (semi-synchronous example)

Meter:

Arm Layer:
Arm Source = Immediate
Arm Count = 1
Arm Trigger Control = Acceptor

Scan Layer:
Scan Source = Immediate
Scan Count = 1
Scan Trigger Control = Acceptor

Measure Layer:
Measure Source = TrigLink
Trigger Link Mode = Semi-Synchronous
Semi-Sync Line = #1
Trigger Control = Acceptor
Measure Count = 10

To run the test, simply press TRIG on the meter to take it out of the idle state and then press STEP on the Model 7001. The following explanation on operation is referenced to the operation model shown in Figure 4-27.

Ⓐ Pressing TRIG takes the meter out of the idle state and places meter operation at point A in the flowchart where it is waiting for a Trigger Link trigger. Note that since both the arm layer and scan layer are programmed for Immediate Source, operation immediately drops down to the measure layer at point A.

Ⓑ Pressing STEP takes the Model 7001 out of the idle state and places operation at point B in the flowchart. Since both the arm and scanner layers are pro-

grammed for Immediate Spacing, immediately and operation drops down to the channel layer at point B.

Ⓒ Since Channel Trigger Control is set for Source, the scan will not wait at point B for a trigger. Instead it will bypass "Wait for Trigger Link Trigger" and close the first channel (point C). Note that the Bypass is only in effect on the first pass through the model.

Ⓓ After the relay settles, the Model 7001 will pull down the Trigger Link trigger line (point D). Since the instrument is programmed to scan 10 channels, operation will loop back up to point B where it will wait for an input trigger. Note that Bypass is no longer in effect.

Ⓔ & Ⓕ Remember that meter operation is at point A waiting for a trigger. When the trigger line was pulled low by the Model 7001, the leading negative-going edge triggers the meter to measure DUT #1 (point E). Note that the meter holds the trigger line low. After the measurement is completed, the meter will release the trigger line (point F) and then loop back to point A where it will wait for another input trigger.

When the meter released the trigger line, the leading positive-going edge triggers the Model 7001 to close the next channel in the scan which in turn pulls the trigger line low triggering the meter to measure the next DUT. This process continues until all 10 channels are scanned and measured.

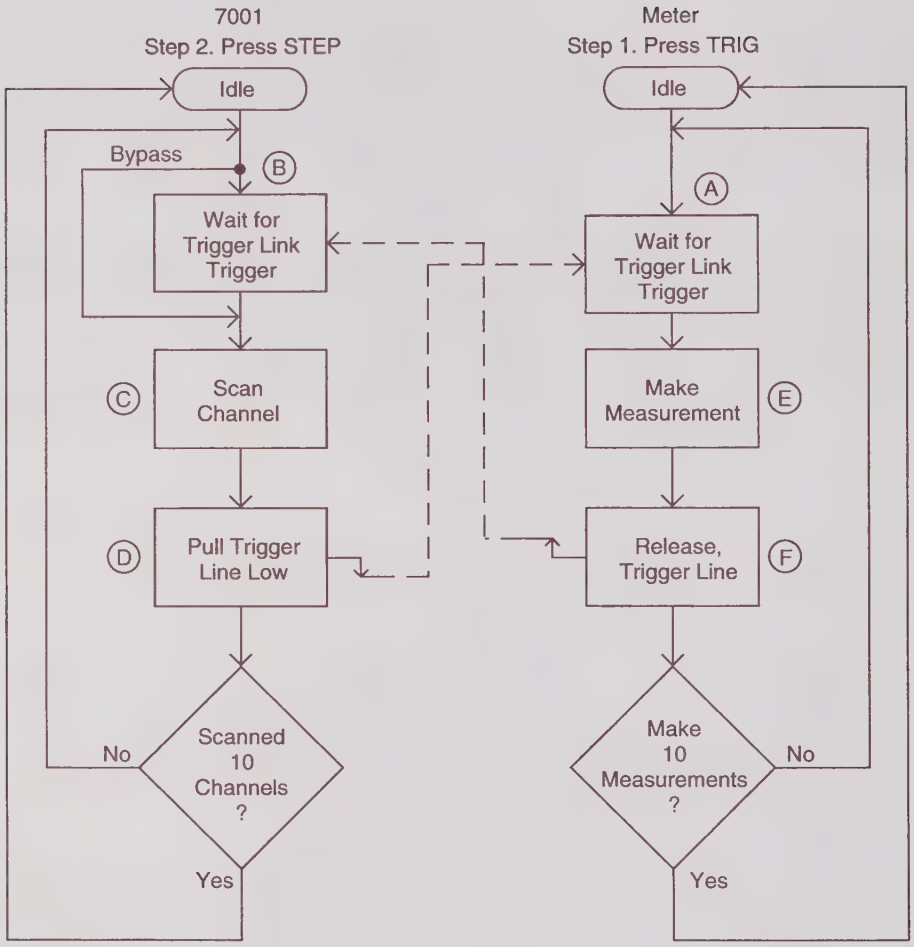


Figure 4-27
Operation model for semi-synchronous Trigger Link example

IEEE-488 Reference

5

IEEE-488 Reference

5.1 Introduction

This section contains reference information on programming the Model 7001 over the IEEE-488 bus and is organized as follows:

5.2 **IEEE-488 bus connections:** Explains instrument connections to the IEEE-488 bus.

5.3 **Primary address selection:** Explains how to set the primary address from the front panel.

5.4 **Controller programming:** Summarizes programming statements using HP BASIC 4.0.

5.5 **Front panel aspects of IEEE-488 operation:** Covers status indicators, messages that pertain to bus operation, and the use of the LOCAL key.

5.6 **Status structure:** Explains the various registers and queues that make up the status structure of the Model 7001.

5.7 **Trigger model:** Explains the scan process (Trigger Model) over the IEEE- 488 bus.

5.8 **General bus commands:** Covers the general IEEE-488 commands required for basic operations, such as placing the unit in remote.

5.9 **Common commands:** Covers the IEEE-488.2 common commands used by the Model 7001.

5.10 **SCPI command subsystems:** Covers the SCPI commands used by the Model 7001.

The IEEE-488 is an instrumentation data bus with hardware and programming standards originally adopted by the IEEE (Institute of Electrical and Electronic Engineers) in 1975 and given the IEEE-488 designation. In 1978 and 1987, the standards were upgraded to IEEE-488-1978 and IEEE-488.1-1987, respectively. The Model 7001 conforms to these standards.

The Model 7001 also conforms to the IEEE-488.2-1987 standard and the SCPI 1991 (Standard Commands for Programmable Instruments) standard. IEEE-488.2 defines a syntax for sending data to and from instruments, how an instrument interprets this data, and what registers should exist to record the state of the instrument. This subset of commands (common commands) is used to perform basic operations, such as reading status registers, triggering measurements, and resetting the device.

The SCPI standard defines a command language protocol. It goes one step farther than IEEE-488.2 and defines a standard set of commands to control every programmable aspect of an instrument. It also defines what format the parameters for those commands should be in and the format for values returned by the instruments.

5.2 IEEE-488 bus connections

The Model 7001 can be connected to the IEEE-488 bus through a cable equipped with standard IEEE-488 connectors, an example is shown in Figure 5-1. The connector can be stacked to allow a number parallel connections to one instrument. Two screws are located on each connector to ensure that connections remain secure. Current standards call for metric threads, which are identified with dark colored screws. Earlier versions had different screws, which were silver colored. Do not attempt to use these type of connectors on the instrument, which is designed for metric threads.

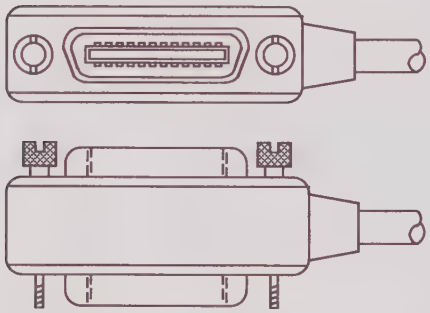


Figure 5-1
IEEE-488 connector

A typical connecting scheme for a multi-unit test system is shown in Figure 5-2. Although any number of connectors could theoretically be stacked on one instrument, it is recommended that you stack no more than three connectors on any one unit to avoid possible mechanical damage.

NOTE

In order to minimize interference caused by electromagnetic radiation, it is recommended that only shielded IEEE-488 cables be used. The Models 7007-1 and 7007-2 shielded IEEE-488 cables are available from Keithley.

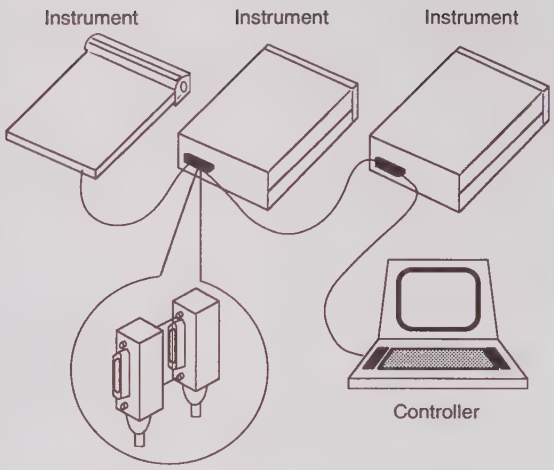


Figure 5-2
IEEE-488 connections

Connect the Model 7001 to the IEEE-488 bus as follows:

1. Line up the cable connector with the connector located on the rear panel. The connector is designed so that it will fit only one way. Figure 5-3 shows the location of the IEEE-488 connector on the instrument.
2. Tighten the screws securely, but do not overtighten them.
3. Add additional connectors from other instruments, as required.
4. Make certain that the other end of the cable is properly connected to the controller. Most controllers are equipped with an IEEE-488 style connector, but a few may require a different type of connecting cable. Consult the instruction manual for your controller for the proper connecting method.

NOTE

The IEEE-488 bus is limited to a maximum of 15 devices, including the controller. The maximum cable length is 20-meters, or two meters times the number of devices, whichever is less. Failure to observe these limits may result in erratic bus operation.

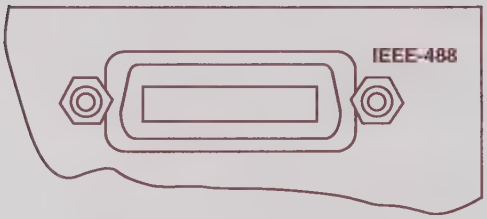


Figure 5-3
IEEE-488 connector location

Custom cables may be constructed by using the information in Table 5-1 and Figure 5-4. Table 5-1 lists the contact assignments for the bus, and Figure 5-4 shows the contact configuration.

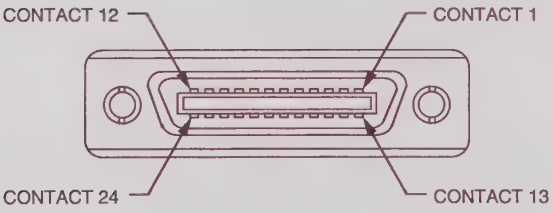


Figure 5-4
Contact assignments

CAUTION

IEEE-488 common is connected to digital common. Maximum voltage between digital common and earth ground is 0V.

Table 5-1
IEEE contact designations

Contact number	IEEE-488 designation	Type
1	DIO1	Data
2	DIO2	Data
3	DIO3	Data
4	DIO4	Data
5	EOI (24)*	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	DIO5	Data
14	DIO6	Data
15	DIO7	Data
16	DIO8	Data
17	REN (24)*	Management
18	Gnd, (6)*	Ground
19	Gnd, (7)*	Ground
20	Gnd, (8)*	Ground
21	Gnd, (9)*	Ground
22	Gnd, (10)*	Ground
23	Gnd, (11)*	Ground
24	Gnd, LOGIC	Ground

*Numbers in parentheses refer to signal ground return of referenced contact number. EOI and REN signal lines return on contact 24.

5.3 Primary address selection

The Model 7001 must receive a listen command before responding to addressed commands. Similarly, the unit must receive a talk command before transmitting data. The Model 7001 is shipped from the factory with a programmed primary address of 7.

The primary address may be set to any value between 0 and 30 as long as address conflicts with other instruments are avoided. Note that controllers are also given a primary address, so do not use that address either. Most frequently, controller addresses are 0 or 21, but you should consult the controller's instruction manual for details. Whatever primary address you choose, you must make certain that it corresponds with the value specified as part of the controller's programming language.

To check the present primary address or to change to a new one, perform the following procedure:

1. Display the MAIN MENU by pressing the MENU key.
2. Use the cursor keys (◁ and ▷) to place the cursor on GPIB and press ENTER. The GPIB SETUP MENU will then be displayed.
3. Use the cursor keys to place the cursor on ADDRESS and press ENTER. The current primary address of the instrument will be displayed. For example, if the instrument is set to primary address 7, the following message will be displayed:

   ADDRESS = 07 (0-30)

4. To retain the displayed address, press EXIT three times to return the instrument to the channel status display state.
5. To change the primary address, use the keypad to display the new address value (0 to 30) and press ENTER. Press EXIT two times to return to the channel status display state.

NOTE

Each device on the bus must have a unique primary address. Failure to observe this precaution will probably result in erratic bus operation.

5.4 Controller programming

The programming instructions covered in this section use examples written with Hewlett-Packard BASIC version 4.0. This language was chosen because of its versatility in controlling the IEEE-488 bus. This section covers those statements that are essential to Model 7001 operation.

NOTE

Controller programming information for using the IBM PC interface through the Capital Equipment Corporation (CEC), I/O Tech, and National IEEE-488 interfaces is located in the Appendix.

A partial list of HP BASIC 4.0 statements is shown in Table 5-2. The statements have a one or three digit argument that must be specified. The first digit is the interface select code, which is set to 7 at the factory. The last two digits of those statements requiring a 3-digit argument specify the primary address.

Those statements with a 3-digit argument show a primary address of 7 (the factory set primary address). For a different address, you would, of course, change the last two digits to the required value. For example, to send a GTL command to a device using a primary address of 17, the following statement would be used: LOCAL 717.

Some of the statements have two forms; the exact configuration depends on the command to be sent over the bus. For example, CLEAR 7 sends a DCL command, while CLEAR 716 sends the SDC command to a device with a primary address of 16.

Table 5-2
HP BASIC 4.0 IEEE-488 statements

Action	BASIC statement
Transmit string to device 07.	OUTPUT 707;A$
Obtain string from device 07.	ENTER 707;A$
Send GTL to device 07.	LOCAL 707
Send SDC to device 07.	CLEAR 707
Send DCL to all devices.	CLEAR 7
Send remote enable.	REMOTE 7
Cancel remote enable.	LOCAL 7
Serial poll device 07.	SPOLL (707)
Send local lockout.	LOCAL LOCKOUT 7
Send GET to device 07.	TRIGGER 707
Send IFC.	ABORT 7

5.5 Front panel aspects of IEEE-488 operation

The following paragraphs discuss aspects of the front panel that are part of IEEE-488 operation, including messages, status indicators, and the LOCAL key.

5.5.1 Front panel error messages

Table 5-3 summarizes the front panel error messages associated with IEEE-488 programming. Note that the instrument may be programmed to generate an SRQ, and command queries can be performed to check for specific error conditions.

Table 5-3
Error and status messages

Code number	Description
+522	"Slot 2 identification error" (EE)
+521	"Slot 1 identification error" (EE)
+510	"Saved state error" (EE)
+173	"Waiting in arm layer 2" (SE)
+172	"Waiting in arm layer 1" (SE)
+171	"Waiting in trigger Layer" (SE)
+161	"Program running" (SE)
+126	"Device calculating" (SE)
+125	"Device measuring" (SE)
+124	"Device sweeping" (SE)
+123	"Device ranging" (SE)
+122	"Device settling" (SE)
+121	"Device calibrating" (SE)
+101	"Operation Complete" (SE)
0	"No error" (SE)
-100	"Command Error" (EE)
-101	"Invalid Character" (EE)
-102	"Syntax Error" (EE
-103	"Invalid Separator" (EE)
-104	"Data Type Error" (EE)
-105	"GET not allowed" (EE)
-108	"Parameter not allowed" (EE)
-109	"Missing Parameter" (EE)
-110	"Command Header Error" (EE)
-111	"Command Header Separator Error" (EE)
-112	"Program mnemonic too long" (EE)
-113	"Undefined header" (EE)
-114	"Header suffix out of range" (EE)
-120	"Numeric data error" (EE)
-121	"Invalid character in number" (EE)
-123	"Exponent too large" (EE)
-124	"Too many digits in number" (EE)
-128	"Numeric data not allowed" (EE)
-140	"Character data error" (EE)
-141	"Invalid character data" (EE)
-144	"Character data too long" (EE)
-148	"Character data not allowed" (EE)
-150	"String data error" (EE)

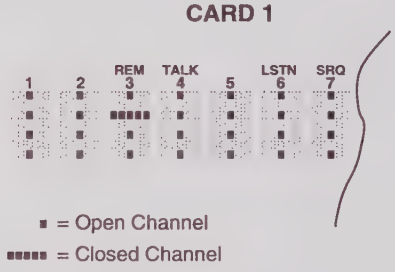
Table 5-3
Error and status messages

Code number	Description
-151	"Invalid string data" (EE)
-154	"String too long"
-158	"String data not allowed" (EE)
-160	"Block data error" (EE)
-161	"Invalid block data" (EE)
-168	"Block data not allowed" (EE)
-170	"Expression error" (EE)
-171	"Invalid expression" (EE)
-178	"Expression data not allowed" (EE)
-200	"Execution error" (EE)
-201	"Invalid while in local" (EE)
-202	"Settings lost due to rtl" (EE)
-210	"Trigger error" (EE)
-211	"Trigger ignored" (EE)
-212	"Arm ignored" (EE)
-213	"Init ignored" (EE)
-214	"Trigger deadlock" (EE)
-215	"Arm deadlock" (EE)
-220	"Parameter Error" (EE)
-221	"Settings conflict" (EE)
-222	"Parameter data out of range" (EE)
-223	"Too much data" (EE)
-224	"Illegal parameter value" (EE)
-241	"Hardware missing" (EE)
-260	"Expression Error" (EE)
-281	"Cannot create program" (EE)
-282	"Illegal program name" (EE)
-284	"Program currently running" (EE)
-285	"Program syntax error" (EE)
-330	"Self Test failed" (EE)
-350	"Queue overflow" (EE)
-410	"Query interrupted" (EE)
-420	"Query unterminated" (EE)
-430	"Query deadlocked" (EE)
-440	"Query unterminated after indefinite response" (EE)

EE = Error event
SE = Status event

5.5.2 IEEE-488 status indicators

The REM (remote), TALK (talk), LSTN (listen), and SRQ (service request) annunciators show the present IEEE-488 status of the instrument. Each of these indicators is briefly described below.



REM — As the name implies, this indicator shows when the instrument is in the remote state. Note that REM does not necessarily indicate the state of the REM line, as the instrument must be addressed to listen with REM true before the REM indicator turns on. When the instrument is in remote, all front panel keys except for the LOCAL key are locked out. When REM is turned off, the instrument is in the local state, and front panel operation is restored.

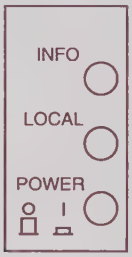
TALK — This indicator is on when the instrument is in the talker active state. The unit is placed in this state by addressing it to talk with the correct MTA (My Talk Address) command. TALK is off when the unit is in the talker idle state. The instrument is placed in the talker idle state by sending it an UNT (Untalk) command, addressing it to listen, or with the IFC (Interface Clear) command.

LSTN — This indicator is on when the Model 7001 is in the listener active state, which is activated by addressing the instrument to listen with the correct MLA (My Listen Address) command. Listen is off when the unit is in the listener idle state. The unit can be placed in the listener idle state by sending UNL (Unlisten), addressing it to talk, or by sending IFC (Interface Clear) over the bus.

SRQ — The instrument can be programmed to generate a service request (SRQ) when one or more errors or conditions occur. When this indicator is on, a service request has been generated. This indicator will stay on until the serial poll byte is read. See paragraph 5.6.8 for details.

5.5.3 LOCAL key

The LOCAL key cancels the remote state and restores local operation of the instrument.

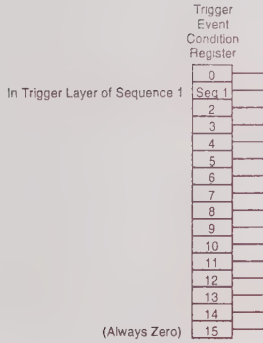


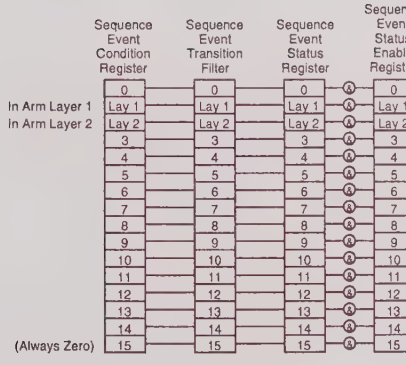
Since all front panel keys except LOCAL are locked out when the instrument is in remote, this key provides a convenient method of restoring front panel operation. Pressing LOCAL also turns off the REM indicator, and returns the display to normal if a user defined message was displayed.

Note that the LOCAL key is also inoperative if the LLO (Local Lockout) command is in effect.

5.6 Status structure

The status register structure of the Model 7001 is shown in Figure 5-5. The following information will explain the various registers and queues that make up this structure.


Trigger Event Condition Register
In Trigger Layer of Sequence 1
Seq 1
(Always Zero)
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15


Sequence Event Condition Register
Sequence Event Transition Filter
Sequence Event Status Register
In Arm Layer 1
In Arm Layer 2
Lay 1
Lay 2
(Always Zero)
0
3
4
5
6
7
8
9
10
11
12
13
14
15

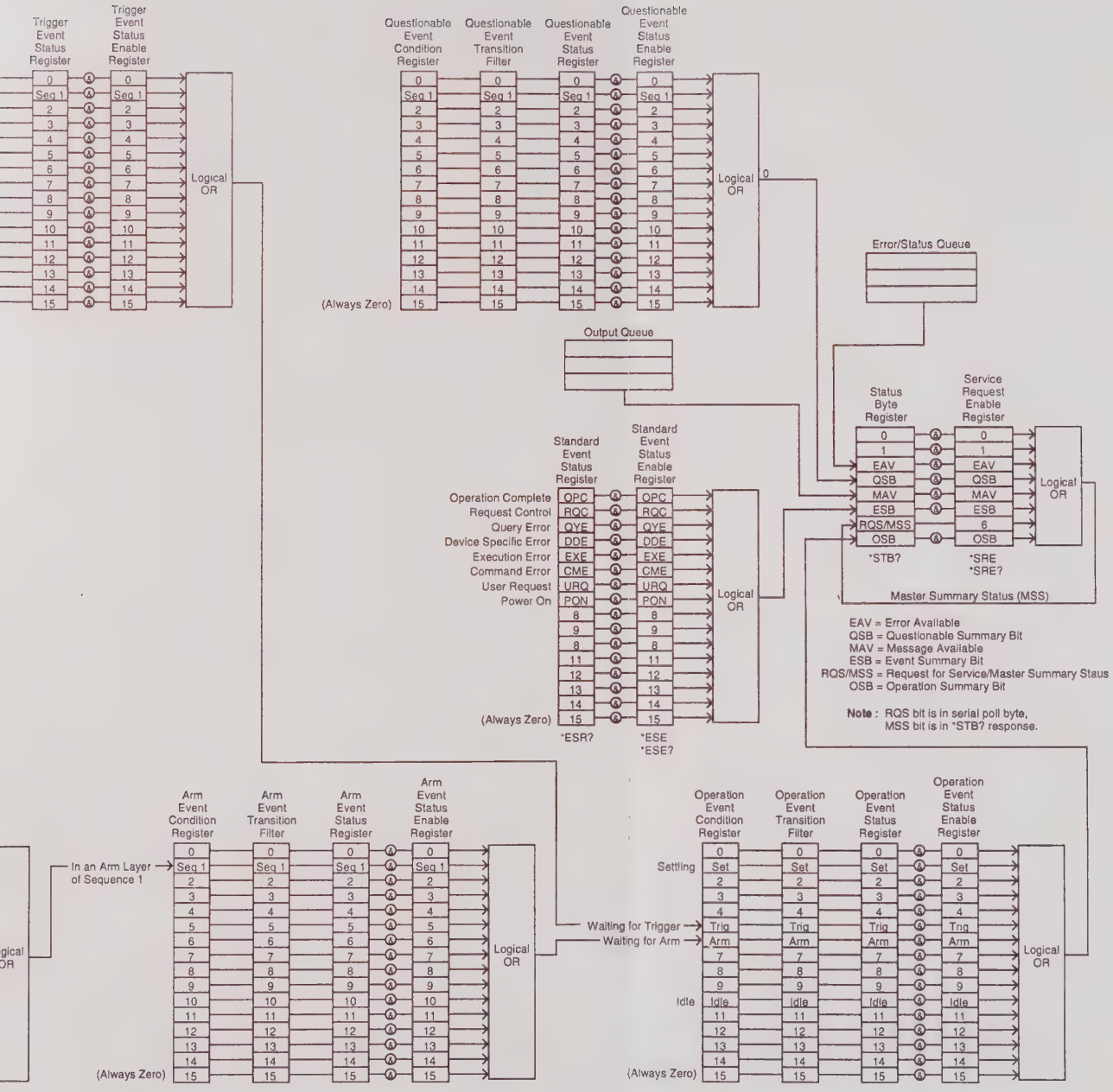


Figure 5-5
Model 7001 status register structure

5.6.1 Standard event status

The reporting of standard events is controlled by two 16-bit registers; the Standard Event Status Register and the Standard Event Status Enable Register. Figure 5-6 shows how these registers are structured. Note that Bits 8 through 15 are not used and are therefore not illustrated.

In general, the occurrence of a standard event sets the appropriate bit in the Standard Event Status Register. This register can be read at any time to determine which, if any, standard events have occurred. Also, with the proper use of the Standard Event Status Enable Register, a standard event can set the Event Summary Bit (ESB) of the Status Byte Register. This allows the programmer to take advantage of the service request (SRQ) feature. See paragraph 5.6.8 for details.

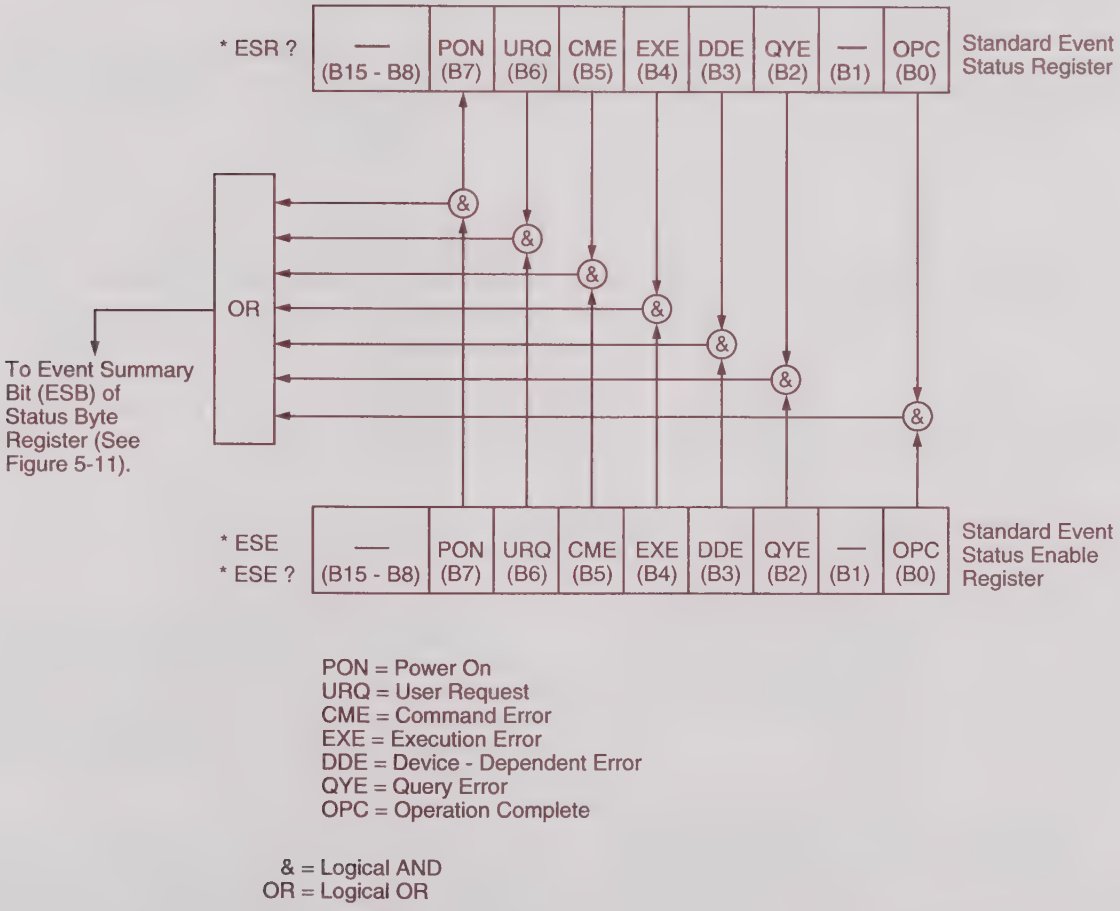


Figure 5-6
Standard event status

Standard Event Status Register — This is a latched register that is used to record the occurrence of standard events. Each bit in the register (except bit B1 which is not used by the Model 7001) represents a standard event. Descriptions of these standard events are provided in paragraph 5.9.4.

When a standard event occurs, the appropriate bit in the Standard Event Status Register sets. For example, if you attempt to read data from an empty Output Queue, a Query Error (QYE) will occur and set bit B2 of the status register. A set bit in this register will remain set until an appropriate operation is performed to clear the register.

The Standard Event Status Register can be read at any time by using the following common query command (see paragraph 5.9.4 for details):

*ESR?

Reading this register using the *ESR? command also clears the register. The following list summarizes all operations that clear the Standard Event Status Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the *ESR? common command.

Standard Event Status Enable Register — This register is programmed by the user and serves as a mask for standard events. When a standard event is masked, the occurrence of that event will not set the Event Summary Bit (ESB) in the Status Byte Register. Conversely, when a standard event is unmasked, the occurrence of that event will set the ESB bit.

A bit in the Standard Event Status Register is masked when the corresponding bit in the Standard Event Status Enable Register is cleared (0). When the masked bit of the Standard Event Status Register sets, it is ANDed with the corresponding cleared bit in the Standard Event Status Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, will not set the ESB bit in the Status Byte Register.

A bit in the Standard Event Status Register is unmasked when the corresponding bit in the Standard Event Status Enable Register is set (1). When the unmasked bit of the Standard Event Status Register sets, it is ANDed with the corresponding set bit in the Standard Event Status Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, sets the ESB bit in the Status Byte Register.

The individual bits of the Standard Event Status Enable Register can be set or cleared by using the following common command (see paragraph 5.9.2 for details):

*ESE <n>

The Standard Event Status Enable register can be read at any time by using the following common query command (see paragraph 5.9.3 for details):

*ESE?

Reading this register using the *ESE? command does not clear the register. The following list summarizes all operations that will clear the Standard Event Status Enable Register:

1. Cycling power.
2. *ESE 0

5.6.2 Operation event status

The reporting of operation events is controlled by a set of 16-bit registers; the Operation Event Condition Register, the Transition Filter, the Operation Event Status Register and the Operation Event Status Enable Register. Figure 5-7 shows how these registers are structured.

Notice in Figure 5-5 that bits B5 (Waiting for Trigger) and B6 (Waiting for Arm) of the Operation Event Condition Register are controlled by the arm event register set and the trigger event register set (see paragraphs 5.6.3 and 5.6.5 for details).

Each of the bits that is used in these registers represent an operation event. Descriptions of the operation event bits are provided in paragraph 5.10.6.

The operation status registers are controlled by the :STATus:OPERation commands in the :STATus Subsystem (see paragraph 5.10.6).

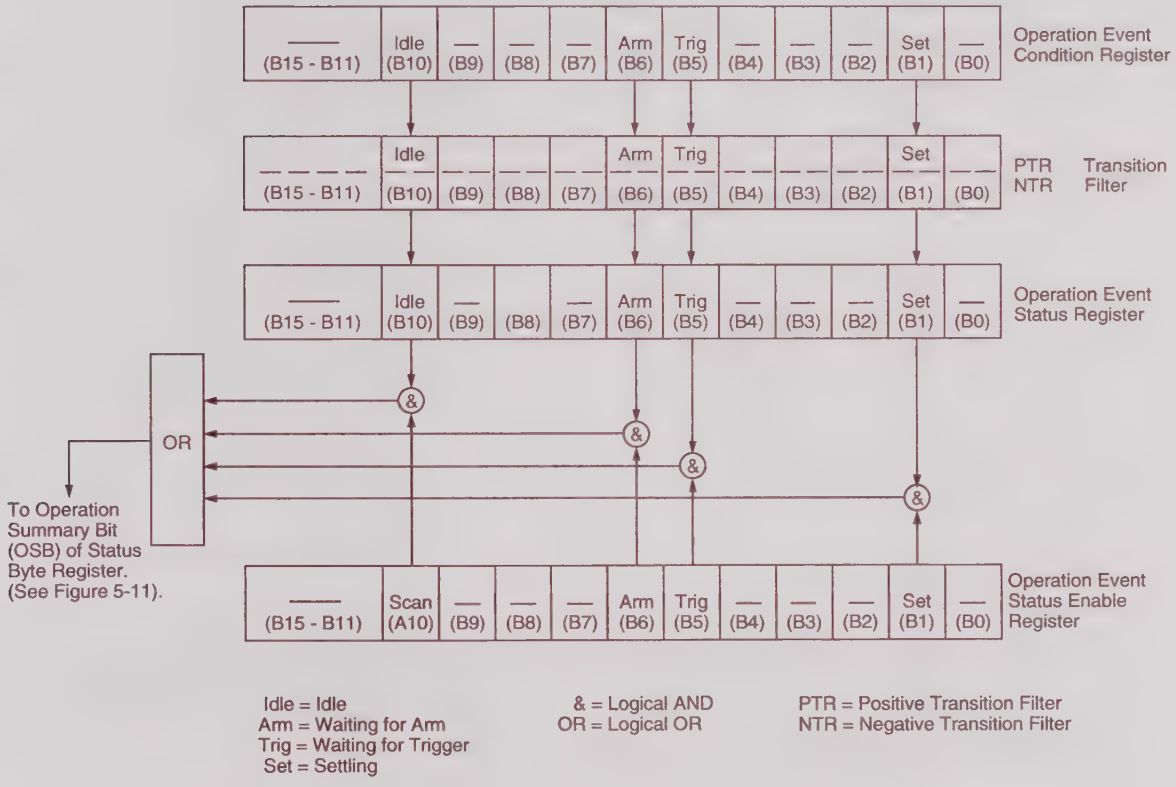


Figure 5-7
Operation event status

Operation Event Condition Register — This is a real-time 16-bit read-only register that constantly updates to reflect the current operating conditions of the Model 7001. For example, after a relay closure, bit B1 (Set) of this register will be set (assuming the status register is programmed for positive transitions). At the completion of the settling time, bit B1 will clear.

The following SCPI query command can be used to read the Operation Event Condition Register:

:STATus:OPERation:CONDition?

The Operation Event Condition Register and the Transition Filter are used to set the bits of the Operation Event Status Register. The Transition Filter is discussed next.

Operation Event Transition Filter — The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) in the Operation Event Condition Register will set the corresponding bit in the Operation Event Status Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Operation Event Status Register will set when the corresponding bit in the Operation Event Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The individual bits of the transition filter registers can be set or cleared by using the following SCPI commands:

:STATus:OPERation:PTR <n>
:STATus:OPERation:NTR <n>

The transition filter registers can be read at any time by using the following SCPI query commands:

:STATus:OPERation:PTR?
:STATus:OPERation:NTR?

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:PTR 65535 and :STATus:OPERation:NTR 0 commands.

Operation Event Status Register — This is a latched, read-only register whose bits are set by the Operation Event Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Operation Event Status Enable Register and applied to an OR gate. The output of the OR gate is the Operation Summary Bit (OSB) that is applied to the Status Byte Register. The following SCPI query command can be used to read the Operation Event Status Register:

:STATus:OPERation?

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Operation Event Status Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation? query command

Operation Event Status Enable Register — This register is programmed by the user and serves as a mask for the Operation Event Status Register. When masked, a set bit in the Operation Event Status Register will not set the Operation Summary Bit (OSB) in the Status Byte Register. Conversely, when unmasked, a set bit in the Operation Event Status Register will set the OSB bit.

A bit in the Operation Event Status Register is masked when the corresponding bit in the Operation Event Status Enable Register is cleared (0). When the masked bit

of the Operation Event Status Register sets, it is ANDed with the corresponding cleared bit in the Operation Event Status Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, will not set the OSB bit in the Status Byte Register.

A bit in the Operation Event Status Register is unmasked when the corresponding bit in the Operation Event Status Enable Register is set (1). When the unmasked bit of the Operation Event Status Register sets, it is ANDed with the corresponding set bit in the Operation Event Status Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, will set the OSB bit in the Status Byte Register.

The individual bits of the Operation Event Status Enable Register can be set or cleared by using the following SCPI command:

:STATus:OPERation:ENABle <n>

The following SCPI query command can be used to read the Operation Event Status Register:

:STATus:OPERation:ENABle?

Reading this register using the above SCPI command does not clear the register. The following list summarizes operations that will clear the Operation Event Status Register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ENABle 0 command.

5.6.3 Arm event status

The reporting of the arm event is controlled by a set of 16-bit registers; the Arm Event Condition Register, the Transition Filter, the Arm Event Status Register, and the Arm Event Status Enable Register. Figure 5-8 shows how these registers are structured.

Notice in Figure 5-5 that bit B1 (In An Arm Layer) of the Arm Event Condition Register is controlled by the sequence event register set (see paragraph 5.6.4 for details). In general, bit B1 sets when the instrument is in arm layer (Arm Layer 1) or scan layer (Arm Layer 2) operation. An explanation of the scan process over bus is provided in paragraph 5.7.

The various registers used for arm event status are described as follows. Note that these registers are controlled by the :STATus:OPERation:ARM commands of the :STATus Subsystem (see paragraph 5.10.6).

Arm Event Condition Register — This is a real-time 16-bit read-only register that constantly updates to reflect the ORed summary of the sequence event register set. In general, if bit B1 is set, the instrument is in an arm layer or has just exited from an arm layer.

The following SCPI query command can be used to read the Arm Event Condition Register:

:STATus:OPERation:ARM:CONDition?

The Arm Event Condition Register and the Transition Filter are used to set the bits of the Arm Event Status Register. The Transition Filter is discussed next.

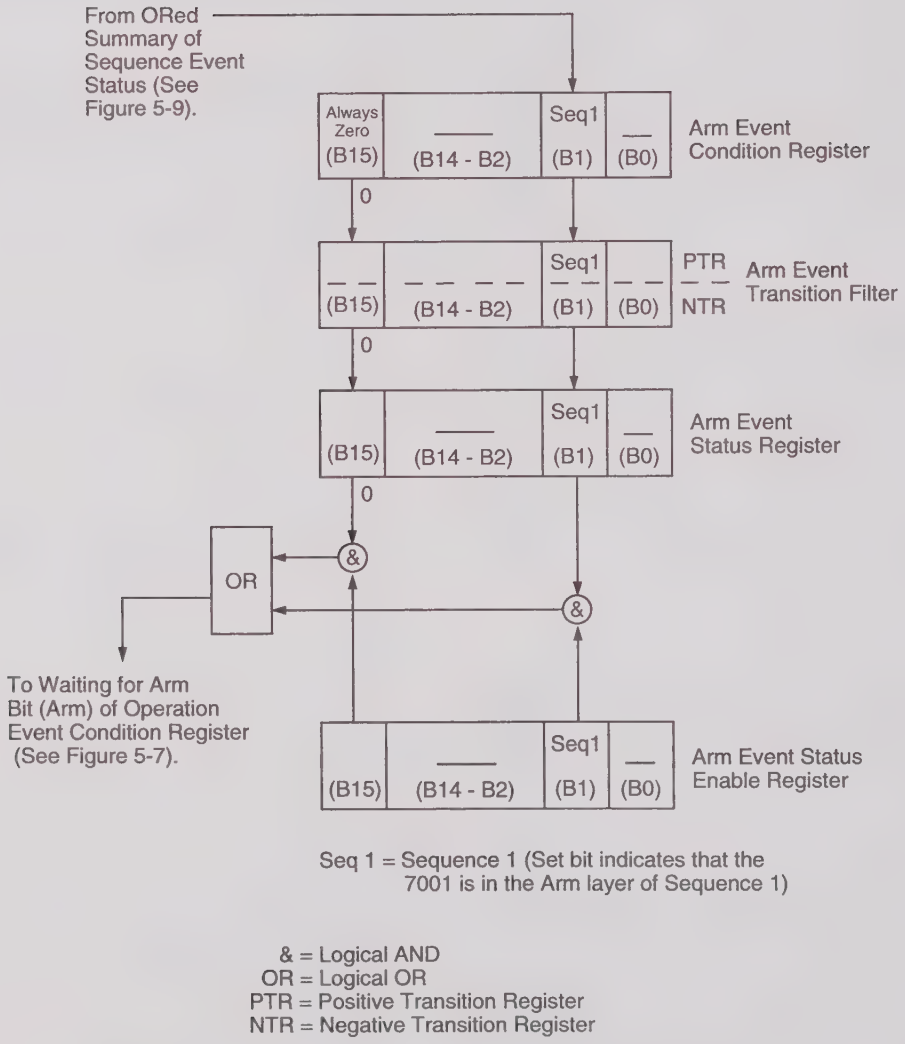

From ORed Summary of Sequence Event Status (See Figure 5-9).
Always Zero
(B15)
(B14 - B2)
Seq1
(B1)
(B0)
Arm Event Condition Register
0
PTR
NTR
Arm Event Transition Filter
Arm Event Status Register
OR
&
To Waiting for Arm Bit (Arm) of Operation Event Condition Register (See Figure 5-7).
Arm Event Status Enable Register
Seq 1 = Sequence 1 (Set bit indicates that the 7001 is in the Arm layer of Sequence 1)
& = Logical AND
OR = Logical OR
PTR = Positive Transition Register
NTR = Negative Transition Register

Figure 5-8
Arm event status

Arm Event Transition Filter — The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) of bit B1 in the Arm Event Condition Register will set bit B1 in the Arm Event Status Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Arm Event Status Register will set when the corresponding bit in the Arm Event Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The transition filter registers can be set or cleared by using the following SCPI commands:

:STATus:OPERation:ARM:PTR <n>
:STATus:OPERation:ARM:NTR <n>

The transition filter registers can be read at any time by using the following SCPI query commands

:STATus:OPERation:ARM:PTR?
:STATus:OPERation:ARM:NTR?

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ARM:PTR 65535 and :STATus:OPERation:ARM:NTR 0 commands.

Arm Event Status Register — This is a latched, read-only register whose bits are set by the Arm Event Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Arm Event Status Enable Register and applied to an OR gate. The output of the OR gate is the Arm Summary Bit (OSB) that is applied to the Status Byte Register. The following SCPI query command can be used to read the Arm Event Status Register:

:STATus:OPERation:ARM?

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Operation Event Status Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:ARM? query command.

Arm Event Status Enable Register — This register is programmed by the user and serves as a mask for the Arm Event Status Register. When masked, a set bit (B1) in the Arm Event Status Register will not set the Arm Summary Bit (OSB) in the Status Byte Register. Conversely, when unmasked, a set bit (B1) in the Arm Event Status Register will set the OSB bit.

Bit B1 in the Arm Event Status Register is masked when the corresponding bit (B1) in the Arm Event Status Enable Register is cleared (0). When the masked bit of the Arm Event Status Register sets, it is ANDed with the corresponding cleared bit in the Arm Event Status Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, will not set the OSB bit in the Status Byte Register.

Bit B1 in the Arm Event Status Register is unmasked when the corresponding bit (B1) in the Arm Event Status Enable Register is set (1). When the unmasked bit of the Arm Event Status Register sets, it is ANDed with the corresponding set bit in the Arm Event Status Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, will set the OSB bit in the Status Byte Register.

Bit B1 of the Arm Event Status Enable Register can be set or cleared by using the following SCPI command:

:STATus:OPERation:ARM:ENABle <n>

The following SCPI query command can be used to read the Arm Event Status Register:

:STATus:OPERation:ARM:ENABle?

Reading this register using the above SCPI command will not clear the register. The following list summarizes operations that will clear the Arm Event Status Register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ARM:ENABle 0 command.

5.6.4 Sequence event status

The reporting of sequence events is controlled by a set of 16-bit registers; the Sequence Event Condition Register, the Transition Filter, the Sequence Event Status Register and the Sequence Event Status Enable Register. Figure 5-9 shows how these registers are structured.

Two bits of this register set are used by the Model 7001 to report sequence events. Bit B1 (In Arm Layer 1) is set when instrument is in (or exited) the arm layer of the scan. Bit B2 (In Arm Layer 2) is set when the instrument is in (or exited) the scan layer. The scan process over the bus is explained in paragraph 5.7.

The various registers used for sequence event status are described as follows. Note that these registers are controlled by the :STATus:OPERation:ARM:SEQuence commands of the :STATus Subsystem (see paragraph 5.10.6).

Sequence Event Condition Register — This is a real-time 16-bit read-only register that constantly updates to reflect the current arm layer status of the instrument. For example, if the Model 7001 is currently in the scan layer of operation, bit B2 (In Arm Layer 2) of this register will be set.

The following SCPI query command can be used to read the Sequence Event Condition Register:

:STATus:OPERation:ARM:SEQuence:CONDition?

The Sequence Event Condition Register and the Transition Filter are used to set the bits of the Sequence Event Status Register. The Transition Filter is discussed next.

Sequence Event Transition Filter — The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) in the Sequence Event Condition Register will set the corresponding bit in the Sequence Event Status Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Sequence Event Status Register will set when the corresponding bit in the Sequence Event Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The transition filter registers can be set or cleared by using the following SCPI commands:

:STATus:OPERation:ARM:SEQuence:PTRansition <n>
:STATus:OPERation:ARM:SEQuence:NTRansition <n>

The transition filter registers can be read at any time by using the following SCPI query commands:

:STATus:OPERation:ARM:SEQuence:PTRansition?
:STATus:OPERation:ARM:SEQuence:NTRansition?

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ARM:SEQuence:PTR 65535 and :STATus:OPERation:ARM:SEQuence:NTR 0 commands.

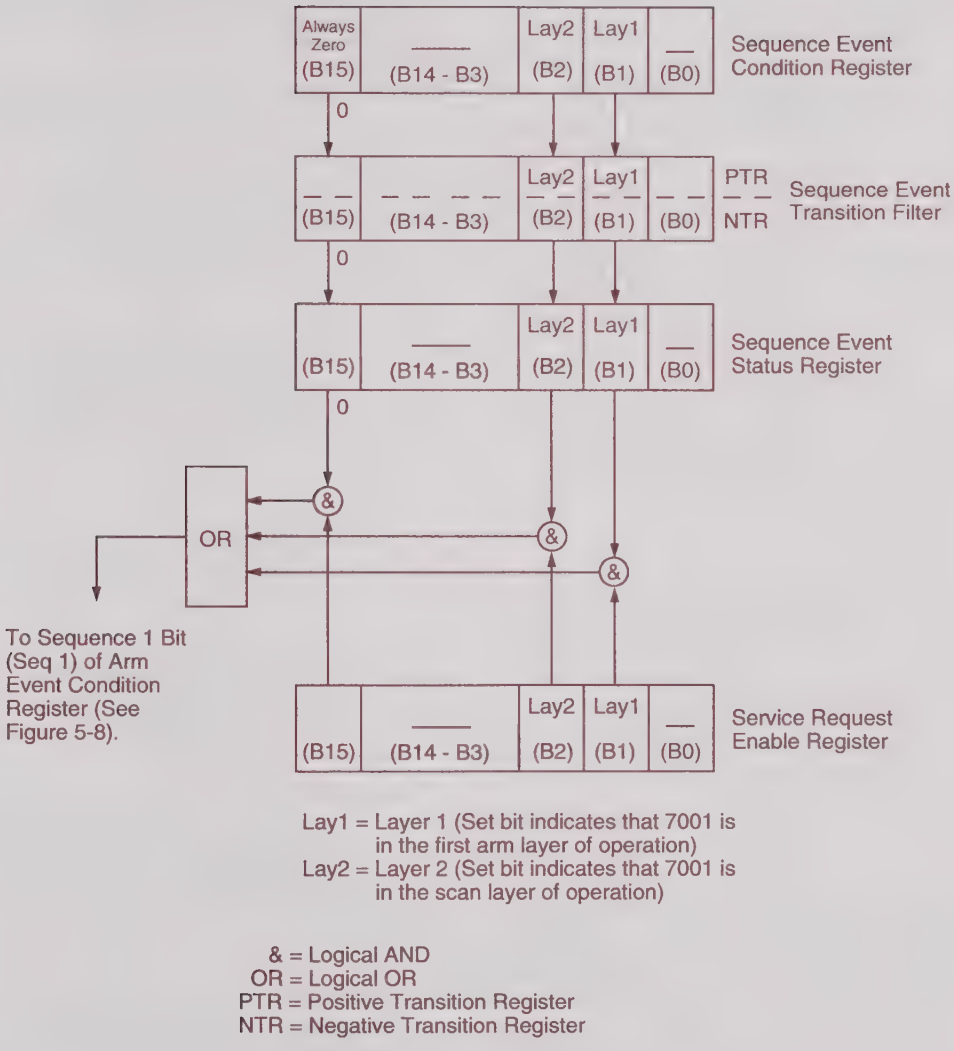

Always Zero
(B15)
(B14 - B3)
Lay2
(B2)
Lay1
(B1)
(B0)
Sequence Event Condition Register
0
PTR
NTR
Sequence Event Transition Filter
Sequence Event Status Register
OR
&
To Sequence 1 Bit (Seq 1) of Arm Event Condition Register (See Figure 5-8).
Service Request Enable Register
Lay1 = Layer 1 (Set bit indicates that 7001 is in the first arm layer of operation)
Lay2 = Layer 2 (Set bit indicates that 7001 is in the scan layer of operation)
& = Logical AND
OR = Logical OR
PTR = Positive Transition Register
NTR = Negative Transition Register

Figure 5-9
Sequence event status

Sequence Event Status Register — This is a latched, read-only register whose bits are set by the Sequence Event Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing sequence. The bits of this register are logically ANDed with the bits of the Sequence Event Status Enable Register and applied to an OR gate. The output of the OR gate is applied to bit B1 of the Arm Event Condition Register (see paragraph 5.6.3). The following SCPI query command can be used to read the Sequence Event Status Register:

:STATus:OPERation:ARM:SEQuence?

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Sequence Event Status Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:ARM:SEQuence? query command.

Sequence Event Status Enable Register — This register is programmed by the user and serves as a mask for the Sequence Event Status Register. When masked, a set bit in the Sequence Event Status Register will not set bit B1 of the Arm Event Condition Register. Conversely, when unmasked, a set bit in the Sequence Event Status Register will set the bit B1 of the Arm Event Condition Register.

A bit in the Sequence Event Status Register is masked when the corresponding bit in the Sequence Event Status Enable Register is cleared (0). When the masked bit of the Sequence Event Status Register sets, it is ANDed with the corresponding cleared bit in the Sequence Event Status Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, will not set bit B1 of the Arm Event Condition Register.

A bit in the Sequence Event Status Register is unmasked when the corresponding bit in the Sequence Event Status Enable Register is set (1). When the unmasked bit of the Sequence Event Status Register sets, it is ANDed with the corresponding set bit in the Sequence Event Status Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, will set bit B1 of the Arm Event Condition Register.

The individual bits of the Sequence Event Status Enable Register can be set or cleared by using the following SCPI command:

:STATus:OPERation:ARM:SEQuence:ENABle <n>

The following SCPI query command can be used to read the Sequence Event Status Register:

:STATus:OPERation:ARM:SEQuence:ENABle?

Reading this register using the above SCPI command will not clear the register. The following list summarizes operations that will clear the Sequence Event Status Register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ARM:SEQuence:ENABle 0 command.

5.6.5 Trigger event status

The reporting of the trigger event is controlled by a set of 16-bit registers; the Trigger Event Condition Register, the Transition Filter, the Trigger Event Status Register, and the Trigger Event Status Enable Register. Figure 5-10 shows how these registers are structured.

Bit B1 (Seq1) of the register set is used for the trigger event (In Trigger Layer of Sequence 1). In general, Bit B1 sets when the instrument is in (or has exited) the channel layer of scan operation. An explanation of the scan process is provided in paragraph 5.7.

The various registers used for trigger event status are described as follows. Note that these registers are controlled by the :STATus:OPERation:TRIGger commands of the :STATus Subsystem (see paragraph 5.10.6).

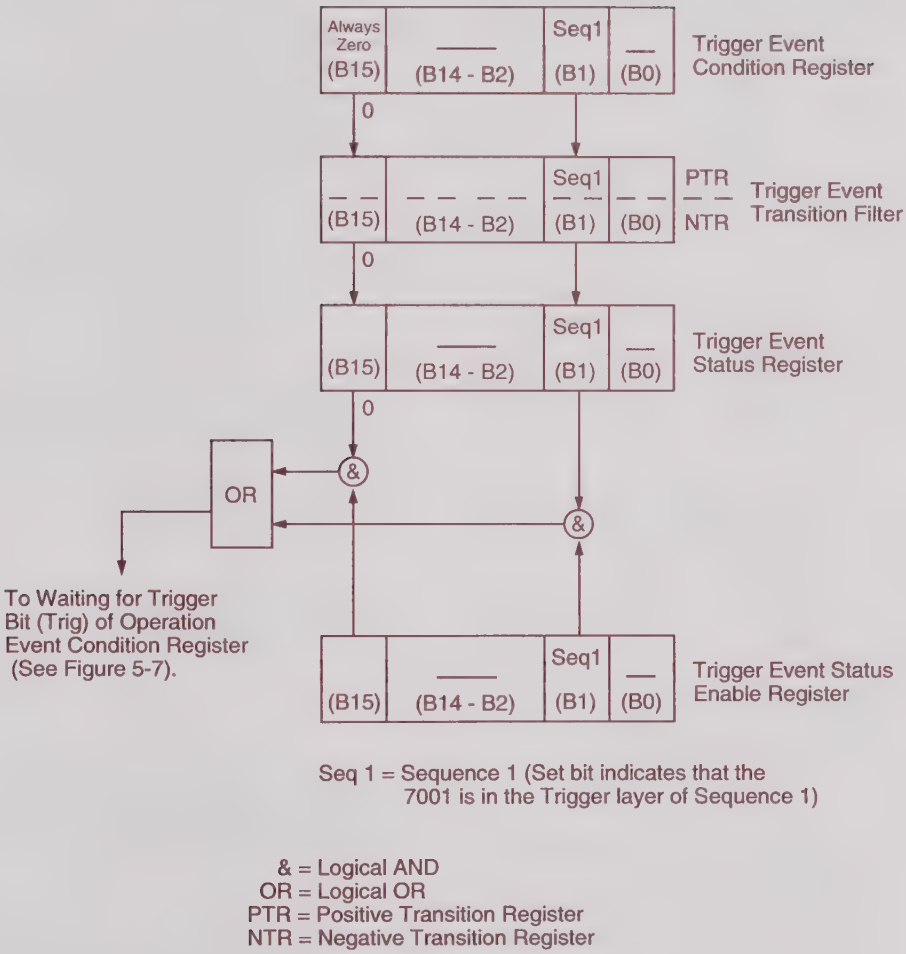


Figure 5-10
Trigger event status

Trigger Event Condition Register — This is a real-time 16-bit read-only register that constantly updates to reflect the trigger layer status of the instrument. If bit B1 is set, the instrument is in the trigger layer (channel layer) of operation.

The following SCPI query command can be used to read the Trigger Event Condition Register:

:STATus:OPERation:TRIGger:CONDition?

The Trigger Event Condition Register and the Transition Filter are used to set bit B1 of the Trigger Event Status Register. The Transition Filter is discussed next.

Trigger Event Transition Filter — The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) of bit B1 in the Trigger Event Condition Register will set bit B1 in the Trigger Event Status Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Trigger Event Status Register will set when the corresponding bit in the Trigger Event Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The transition filter registers can be set or cleared by using the following SCPI commands:

:STATus:OPERation:TRIGger:PTRansition <n>
:STATus:OPERation:TRIGger:NTRansition <n>

The transition filter registers can be read at any time by using the following SCPI query commands:

:STATus:OPERation:TRIGger:PTRansition?
:STATus:OPERation:TRIGger:NTRansition?

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:TRIGger:PTR 65535 and :STATus:OPERation:TRIGger:NTR 0 commands.

Trigger Event Status Register — This is a latched, read-only register whose bits are set by the Trigger Event Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Trigger Event Status Enable Register and applied to an OR gate. The output of the OR gate is applied to bit B5 (Waiting for Trigger) of the Operation Event Condition Register.

The following SCPI query command can be used to read the Trigger Event Status Register:

:STATus:OPERation:TRIGger?

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Trigger Event Status Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:TRIGger? query command.

Trigger Event Status Enable Register — This register is programmed by the user and serves as a mask for the Trigger Event Status Register. When masked, a set bit (B1) in the Trigger Event Status Register cannot set bit B5 (Waiting for Trigger) of the Operation Event Condition Register. Conversely, when unmasked, a set bit (B1) in the Trigger Event Status Register will set bit B5 of the Operation Event Condition Register.

Bit B1 in the Trigger Event Status Register is masked when the corresponding bit (B1) in the Trigger Event Status Enable Register is cleared (0). When the masked bit of the Trigger Event Status Register sets, it is AND-ed with the corresponding cleared bit in the Trigger Event Status Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, cannot set bit B5 of the Operation Event Condition Register.

Bit B1 in the Trigger Event Status Register is unmasked when the corresponding bit (B1) in the Trigger Event Status Enable Register is set (1). When the unmasked bit of the Trigger Event Status Register sets, it is AND-ed with the corresponding set bit in the Trigger Event Status Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, will set bit B5 of the Operation Event Condition Register

Bit B1 of the Trigger Event Status Enable Register can be set or cleared by using the following SCPI command:

:STATus:OPERation:TRIGger:ENABle <n>

The following SCPI query command can be used to read the Trigger Event Status Register:

:STATus:OPERation:TRIGger:ENABle?

Reading this register using the above SCPI command will not clear the register. The following list summarizes operations that will clear the Trigger Event Status Register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:TRIGgr:ENABle 0 command.

5.6.6 Questionable event status

The Model 7001 does not implement questionable events. Thus, the QSB summary bit is always zero as shown in Figure 5-5. Even though they are not used, the questionable event registers are part of the status structure as required by SCPI.

5.6.7 Queues

The Model 7001 uses two queues; the Output Queue and the Error/Status Queue. The queues are first-in first-out (FIFO) registers. They are used to hold data messages and error/status messages respectively. The Model 7001 Status Model (Figure 5-5) shows how the two queues are structured with the other registers.

Output Queue—The Output Queue is used to hold all data that pertains to the normal operation of the instrument. For example, when a query command is sent, the data message that pertains to that query is placed in the Output Queue.

When a data message is placed in the Output Queue, the Message Available (MAV) bit in the Status Byte Register becomes set. A data message is cleared from the Output Queue when it is read. The Output Queue is considered cleared when it is empty. An empty Output Queue clears the MAV bit in the Status Byte Register.

A message from the Output Queue is read by addressing the Model 7001 to talk. The following programming example in HP BASIC 4.0 sends a query command, sends the data message to the computer, and then displays it on the CRT.

```
10 OUTPUT 707; "*IDN?"    ! Request identification code
20 ENTER 707; A$          ! Address 7001 to talk
30 PRINT A$               ! Display ID code
40 END
```

Error/Status Queue—The Error/Status Queue is used to hold error messages and status messages. When an error or status event occurs, a message that defines the error/status is placed in the Error/Status Queue. This queue will hold up to 10 messages.

When a message is placed in the Error/Status Queue, the Error Available (EAV) bit in the Status Byte Register

is set. An error message is cleared from the Error/Status Queue when it is read. The Error/Status Queue is considered cleared when it is empty. An empty Error/Status Queue clears the EAV bit in the Status Byte Register.

An error message from the Error/Status Queue is read by sending either of the following SCPI query commands and then addressing the Model 7001 to talk:

:SYSTem:ERRor?

:STATus:QUEue?

Refer to paragraphs 5.10.6 (:STATus:QUEue?) and 5.10.7 (:SYSTem:ERRor?) for complete information on reading error messages.

5.6.8 Status byte and service request (SRQ)

Service request is controlled by two 16-bit registers; the Status Byte Register and the Service Request Enable Register. The structure of these registers are shown in Figure 5-11. Note that bits B8 through B15 are not shown since they are not used.

Status Byte Register — The summary messages from the status registers and queues are used to set or clear the appropriate bits (B2, B3, B4, B5 and B7) of the Status Byte Register. These bits do not latch and their states (0 or 1) are solely dependent on the summary messages (0 or 1). For example, if the Standard Event Status Register is read, its register will clear. As a result its summary message will reset to 0, which in turn will reset the ESB bit in the Status Byte Register.

Bit B6 in the Status Byte Register is either:

- The Master Summary Status (MSS) bit, sent in response to the *STB? command, indicates the status of any set bits with corresponding enable bits set.
- The Request for Service (RQS) bit, sent in response to a serial poll, indicates which device was requesting service by pulling on the SRQ line.

For description of the other bits in the Status Byte Register, refer to paragraph 5.9.14.

The IEEE-488.2 standard uses the following common query command that simply reads the Status Byte Register contents:

*STB?

When reading the Status Byte Register using the *STB? command, bit B6 is called the MSS bit. None of the bits in the Status Byte Register are cleared when using the *STB? command to read it.

The IEEE-488.1 standard has a serial poll sequence that will also read the Status Byte Register and is better suited to detect a service request (SRQ). When using the serial poll, bit B6 is called the RQS bit. Serial polling causes bit B6 (RQS) to reset. Serial polling is discussed in more detail later in this paragraph (see "Serial Poll and SRQ").

The following operations clears all bits of the Status Byte Register:

1. Cycling power.
2. Sending the *CLS common command.

NOTE

The MAV bit may or may not be cleared.

Service Request Enable Register — This register is programmed by the user and serves as a mask for the Status Summary Message bits (B2, B3, B4, B5 and B7) of the Status Byte Register. When masked, a set summary bit in the Status Byte Register will not set bit B6 (MSS/RQS) of the Status Byte Register. Conversely, when unmasked, a set summary bit in the Status Byte Register will set bit B6.

A Status Summary Message bit in the Status Byte Register is masked when the corresponding bit in the Service Request Enable Register is cleared (0). When the masked summary bit in the Status Byte Register sets, it is ANDed with the corresponding cleared bit in the Service Request Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, will not set the MSS/RQS bit in the Status Byte Register.

A Status Summary Message bit in the Status Byte Register is unmasked when the corresponding bit in the Service Request Enable Register is set (1). When the unmasked summary bit in the Status Byte Register sets, it is ANDed with the corresponding set bit in the Service Request Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, will set the MSS/RQS bit in the Status Byte Register.

The individual bits of the Service Request Enable Register can be set or cleared by using the following common command (see paragraph 5.9.12 for details):

*SRE <n>

The Service Request Enable Register can be read using the following common query command (see paragraph 5.9.13 for details):

*SRE?

The Service Request Enable Register is not cleared when it is read using the *SRE? query command. The Service Request Enable Register will clear when power is cycled or a parameter (n) value of zero is sent with the *SRE command (*SRE 0).

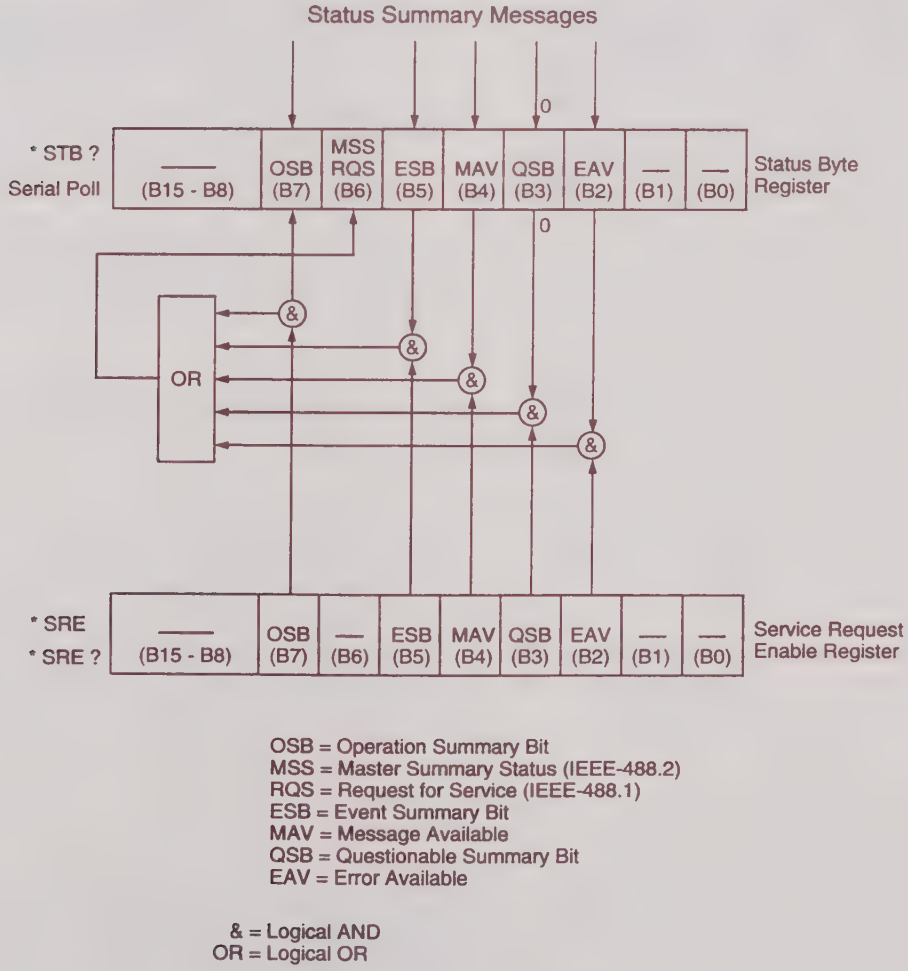


Figure 5-11
Status byte and service request (SRQ)

Serial poll and SRQ

The user's test program can periodically read the Status Byte Register to check to see if a service request (SRQ) has occurred and what caused it. In the event of an SRQ, the program can, for example, branch to an appropriate subroutine that will service the request.

Typically, service requests (SRQs) are managed by the serial poll sequence of the Model 7001. If an SRQ does not occur, bit B6 (RQS) of the Status Byte Register will remain cleared and the program will simply proceed normally after the serial poll is performed. If an SRQ does occur, bit B6 of the Status Byte Register will set and the program can branch to a service subroutine when the SRQ is detected by the serial poll. The serial poll will automatically reset Bit 6 of the Status Byte Register. This will allow subsequent serial polls to monitor that bit for the next SRQ occurrence.

The following HP BASIC 4.0 programming example demonstrates how serial poll can be used to detect an SRQ.

```
10  REMOTE 707
20  CLEAR 707
30  OUTPUT 707; "*ESE 32"      ! Unmask command
                                 error (B5) in SESER.
40  OUTPUT 707; "*SRE 32"      ! Unmask event sum-
                                 mary (B5) in SRER.
50  OUTPUT 707; "*ESE"         ! Program command
                                 error (missing pa-
                                 rameter) to generate
                                 SRQ.
60  WAIT 1
70  S=SPOLL (707)              ! Serial poll 7001.
80  IF BIT (S,6) THEN          ! Go to Service subrou-
    service                      tine (line 200).
90  END
200 SUB Service
210 PRINT "B7 B6 B5 B4 B3      ! Identify bits.
    B2 B1 B0"
220 FOR I = 7 TO 0 STEP -1     ! Loop eight times.
230 PRINT BIT (S,I)            ! Display bit values
240 NEXT I
250 SUBEND
```

Program Analysis:

Line 10 - Place 7001 in remote.

Line 20 - Perform a device clear.

Line 30 - Set bit B5 of Standard Event Status Enable Register. This unmasks the command error event.

Line 40 - Set bit B5 of the Service Request Enable Register. This unmasks the event summary message.

Line 50 - Send an illegal command in order to generate an SRQ.

Line 60 - Wait for a second to ensure completion of SRQ.

Line 70 - Serial poll the Model 7001.

Line 80 - If SRQ occurred, bit B6 in Status Byte Register will be set and program will go to Service subroutine.

Line 200 to 240 - Service subroutine displays the bit values (0 or 1) of the Status Byte Register. For this example, bit B5 (ESB) and bit B6 (RQS) will be set.

The actual serial poll sequence is explained in paragraph 5.8.8.

5.7 Trigger model (IEEE-488 scan process)

The following information describes the scan process over the IEEE-488 bus. The flowchart in Figure 5-12, which summarizes scan operation over the bus, is called the Trigger Model. It is called the Trigger Model because operation is controlled by SCPI commands from the Trigger Subsytem (see paragraph 5.10.8). Notice that key SCPI commands are included in the Trigger Model.

Idle

The instrument is considered to be in the idle state whenever it is not operating within one of the layers of the Trigger Model. The front panel ARM indicator is off when the instrument is in the idle state. While in the idle state, the instrument cannot perform a scan.

Over the bus, there are two SCPI commands that can be used to take the instrument out of the idle state; :INITiate or :INITiate:CONTinuous ON. When not in the idle state (ARM indicator on) the scanning function is considered to enabled.

Notice that with continuous initiation enabled (:init:cont on), the instrument will not return to the idle state after all programmed scan operations are completed. However, the instrument can be returned to the idle state at any time by sending the *RST. The instrument can also be returned to the idle state by sending the :ABORt command with continuous initiation disabled (:init:cont off).

Once the instrument is taken out of the idle state, operation proceeds into the arm layer (Arm Layer 1) of the Trigger Model.

Arm layer 1

NOTE

For front panel operation, this layer is called the arm layer.

In general, the instrument requires an arm event to allow operation to proceed to the next layer (Arm layer 2). With the Immediate control source selected (:ARM:SOURce IMMediate), operation immediately proceeds to the next layer when the instrument is taken out of the idle state. The *RST and :SYSTem:PRESet commands also set the arm control source to Immediate. With one of the other control sources selected, the instrument will wait until the appropriate event occurs.

With the Manual control source selected (:ARM :SOURce MANual), the instrument will wait until the front panel STEP key is pressed. Note that the Model 7001 must be taken out of remote (press LOCAL key or send LOCAL 707 over bus) before it will respond to the STEP key. With the Bus control source selected (:ARM:SOURce BUS), the instrument will wait until a bus trigger is received (GET or *TRG). With the External control source selected (:ARM:SOURce EXTernal), the instrument will wait until an input trigger (via EXTERNAL TRIGGER connector on rear panel) is received. With the Trigger Link control source selected (:ARM:SOURce TLINk), the instrument will wait until an input trigger is received (via TRIGGER LINK). With the Hold control source selected (:ARM:SOURce HOLD), the instrument will not respond to any of the control source events.

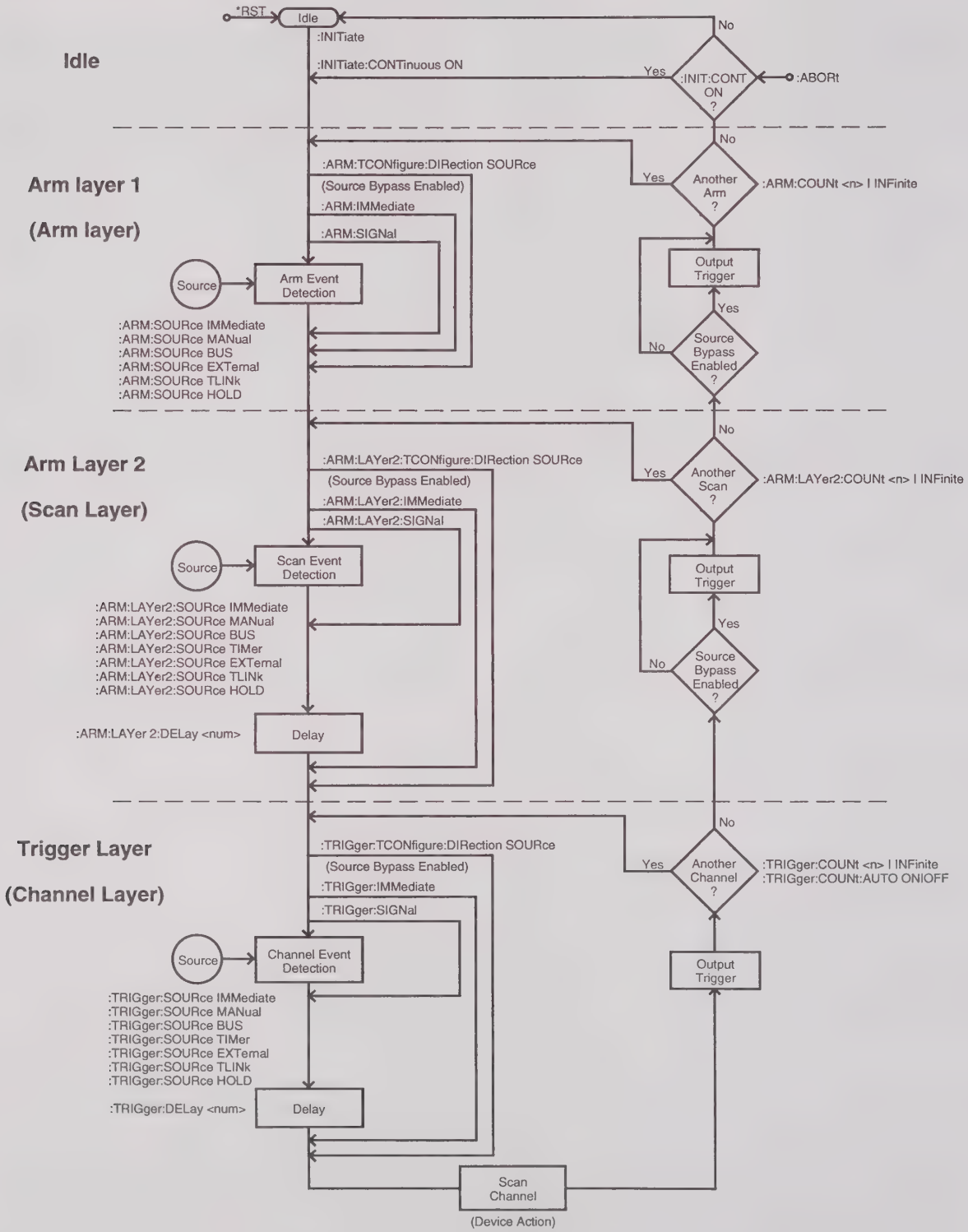


Figure 5-12
Trigger model (IEEE-488 scan process)

As can be seen in the flowchart, there are three paths that allow operation to loop around the control source. These three paths are described as follows:

1. When the Source Bypass is enabled (:ARM :TCONfigure:DIRection SOURce) and the External or Trigger Link control source is selected, operation will loop around the control source on the initial pass through Arm layer 1. If programmed for another arm (arm count > 1), the bypass loop will not be in effect even though it will still be enabled. The Source Bypass loop will reset (be in effect) if operation goes into Idle.

   Enabling the Source Bypass also enables the Output Trigger. When operation returns to Arm layer 1 from Arm layer 2, an output trigger pulse will occur. If the Trigger Link control source is selected, the output trigger pulse will be available on the programmed TRIGGER LINK output line. For all other control source selections, the output trigger pulse will be available at the CHANNEL READY connector. The Output Trigger in this layer is disabled when the Source Bypass is disabled (:ARM :TCONfigure:DIRection ACCeptor).

2. Each time the :ARM:IMMediate command is sent, operation will loop around the arm control source. It is used when you do not wish to wait for a programmed arm event to occur (or when the Hold control source is selected).
3. When the signal path is enabled (:ARM:SIGnal), operation will loop around the arm control source on the initial pass through Arm layer 1. This path functions in the same manner as the Source Bypass, except that it does not enable the Output Trigger.

After all other scanning operations have been completed, the instrument can be returned to Arm Layer 1 by programming the instrument for additional arms. The :ARM:COUNt <n> | INFinite command can be used to set the arm count to a finite value (where n = 1 to 9999) or for an infinite (INF) number of arms. The *RST and :SYSTem:PRESet commands set the arm count to 1.

After the instrument leaves Arm layer 1, operation proceeds into the scan layer (Arm layer 2).

Arm layer 2

NOTE

For front panel operation, this layer is called the scan layer.

In general, the instrument requires a scan event to allow operation to proceed to the next layer (trigger layer). With the Immediate control source selected (:ARM:LAYer2:SOURce IMMediate), operation immediately proceeds to the next layer. The *RST and :SYSTem:PRESet commands also set the scan control source to Immediate. With one of the other control sources selected, the instrument will wait until the appropriate event occurs.

With the Timer control source selected (:ARM :LAYer2:SOURce TIMer), operation will immediately proceed into the Trigger Layer on the initial pass through Arm Layer 2. Each additional scan will not occur until the programmed timer interval elapses. The timer can be set to an interval from 1msec to 99999.999 seconds.

With the Manual control source selected (:ARM :LAYer2:SOURce MANual), the instrument will wait until the front panel STEP key is pressed. Note that the Model 7001 must be taken out of remote (press LOCAL key or send LOCAL 707 over bus) before it will respond to the STEP key. With the Bus control source selected (:ARM:LAYer2:SOURce BUS), the instrument will wait until a bus trigger is received (GET or *TRG). With the External control source selected (:ARM :LAYer2:SOURce EXTernal), the instrument will wait until an input trigger (via EXTERNAL TRIGGER connector on rear panel) is received. With the Trigger Link control source selected (:ARM:LAYer2:SOURce TLINk), the instrument will wait until an input trigger is received (via TRIGGER LINK). With the Hold control source selected (:ARM:LAYer2:SOURce HOLD), the instrument will not respond to any of the control source events.

After the programmed scan event is detected, the instrument will wait for the programmed Delay to time out. The :ARM:LAYer2:DELay <num> command is used to set the Delay (where num = 0 to 99999.999 seconds). The *RST and :SYSTem:PRESet commands set the Delay to zero seconds.

As can be seen in the flowchart, there are three paths that allow operation to loop around the control source. Two of these paths also loop around the Delay. These three paths are described as follows:

1. When the Source Bypass is enabled (:ARM:TCONfigure:DIRection SOURce) and and the External or Trigger Link control source is selected, operation will loop around the control source on the initial pass through Arm layer 2. If programmed for another scan (scan count > 1), the bypass loop will not be in effect even though it will still be enabled. The Source Bypass loop will reset (be in effect) if operation goes back into Arm layer 1.

   Enabling the Source Bypass also enables the Output Trigger. When operation returns to Arm layer 2 from the trigger layer, an output trigger pulse will occur. If the Trigger Link control source is selected, the output trigger pulse will be available on the programmed TRIGGER LINK output line. For all other control source selections, the output trigger pulse will be available at the CHANNEL READY connector. The Output Trigger in this layer is disabled when the Source Bypass is disabled (:ARM:TCONfigure:DIRection ACCeptor).

2. Each time the :ARM:LAYer2:IMMediate command is sent, operation will loop around the scan control source and the Delay. It is used when you do not wish to wait for a programmed scan event to occur (or when the Hold control source is selected).
3. When the signal path is enabled (:ARM:LAYer2 :SIGnal), operation will loop around the scan control source on the initial pass through Arm Layer 2. This path functions the same as Source Bypass, except that it does not enable the Output Trigger and it does not loop around the Delay.

After all other operations in the next layer have been completed, the instrument can be returned to Arm layer 2 by programming the instrument for additional scans. The :ARM:LAYer2:COUNt <n>|INFinite command can be used to set the scan count to a finite value (where n = 1 to 9999) or for an infinite (INF) number of scans. The *RST command sets the scan count to one and the :SYSTem:PRESet command sets the scan count to infinite.

After the instrument leaves Arm layer 2, operation proceeds to the channel layer (trigger layer).

Trigger layer

NOTE

For front panel operation, this layer is called the channel layer.

In general, channel events control the channel scan rate. With the Immediate control source selected (:TRIGger:SOURce IMMediate), operation immediately proceeds to the the Delay. The *RST command also sets the channel control source to Immediate. With one of the other control sources selected, the instrument will wait until the appropriate event occurs.

With the Timer control source selected (:TRIGger :SOURce TIMer), the first channel will be scanned immediately. Each additional channel will be scanned at a rate determined by the programmed timer interval (1msec to 99999.999 seconds).

With the Manual control source selected (:TRIGger :SOURce MANual), the instrument will wait until the front panel STEP key is pressed. Note that the Model 7001 must be taken out of remote (press LOCAL key or send LOCAL 707 over bus) before it will respond to the STEP key. The :SYSTem:PRESet command also selects the Manual control source.

With the Bus control source selected (:TRIGger :SOURce BUS), the instrument will wait until a bus trigger is received (GET or *TRG). With the External control source selected (:TRIGger:SOURCE EXTernal), the instrument will wait until an input trigger (via EXTERNAL TRIGGER connector on rear panel) is received. With the Trigger Link control source selected (:TRIGger:SOURce TLINk), the instrument will wait until an input trigger is received (via TRIGGER LINK). With the Hold control source selected (:TRIGger :SOURce HOLD), the instrument will not respond to any of the control source events.

After the programmed channel event is detected, the instrument will wait for the programmed Delay to time out. The :TRIGger:DELay <num> command is used to set the Delay (where num = 0 to 99999.999 seconds). The *RST and :SYSTem:PRESet commands set the Delay to zero seconds.

As can be seen in the flowchart, there are three paths that allow operation to loop around the control source. Two of these paths also loop around the Delay. These three paths are described as follows:

1. When the Source Bypass is enabled (:ARM :TCONfigure:DIRection SOURce) and and the External or Trigger Link control source is selected, operation will loop around the control source on the initial pass through Arm layer 2. If programmed to scan another channel (channel count > 1), the bypass loop will not be in effect even though it will still be enabled. The Source Bypass loop will reset (be in effect) if operation goes back to Arm layer 2.
2. Each time the :TRIGger:IMMediate command is sent, operation will loop around the scan control source and the Delay. It is used when you do not wish to wait for a programmed scan event to occur (or when the Hold control source is selected).
3. When the signal path is enabled (:TRIGger :SIGnal), operation will loop around the control source on the initial pass through Arm layer 2. This path functions the same as the Source Bypass, except that it does not not loop around the Delay.

At this point the first (or next) channel in the Scan List will be scanned (Device Action). When scanning channels, the previous channel will open and the next channel will close (break-before-make). Also included in the Device Action is the internal settling time delay for the relay and any additional programmed settling time delay using the :STIMe command of the :ROUTe Subsystem (see paragraph 5.10.3).

After a channel is scanned, an Output Trigger will occur. If the channel control source is programmed for Immediate, Manual, Bus or Timer, the output trigger pulse will be available at the CHANNEL READY connector. If the Trigger Link control source is selected, Output Trigger action will occur as follows:

1. If the asynchronous Trigger Link mode is selected, the output trigger pulse will be available on the programmed TRIGGER LINK output line.
2. If the semi-synchronous Trigger Link mode is selected and the Source Bypass is disabled (:trig :tcon:dir acc), the Trigger Link line will be released (goes high).
3. If the semi-synchronous Trigger Link mode is selected and the Source Bypass is enabled (:trig :tcon:dir sour), the Trigger Link line will be pulled down low and then released.

Note: See paragraph 4.11 for details on using the Trigger Link.

After a channel is scanned and an output trigger occurs, the instrument will (if programmed to do so) return to the beginning of the trigger layer to scan another channel. The :TRIGger:COUNt <n> | INFinite command is used to set the channel count to a finite value (where n = 1 to 9999) or for a continuous scan of the Channel List (INFinite). The :TRIGger:COUNt :AUTo ON command is used to automatically set the channel count to the length of the Scan List. The *RST command sets the channel count to one and the :SYSTem:PRESet command enables the automatic channel count.

5.8 General bus commands

General bus commands are those commands such as DCL that have the same general meaning regardless of the instrument. Commands supported by the Model 7001 are listed in Table 5-4 which also lists BASIC statements necessary to send each command. Note that commands requiring that a primary address be specified assume that the primary address is set to 16. This is the address that is set at the factory.

5.8.1 REN (remote enable)

The remote enable command is sent to the Model 7001 by the controller to set up the instrument for remote operation. Generally, the instrument should be placed in the remote mode before you attempt to program it over the bus. Simply setting REN true does not actually place the instrument in the remote state. Instead the instrument must be addressed to listen after setting REN true before it goes into remote.

Note that the instrument need not be in remote to be a talker.

Programming Example — This sequence is automatically performed by the controller when the following is typed into the keyboard.

```
REMOTE 707
```

After the RETURN key is pressed, the instrument is in the remote state, as indicated by the REM annunciator. If not, check to see that the instrument is set to the proper primary address 07, and check to see that the bus connections are properly made.

Note that all front panel controls except for LOCAL (and, of course, POWER) are inoperative while the instrument is in remote. You can restore normal front panel operation by pressing the LOCAL key.

Table 5-4
General bus commands and associated BASIC statements

Command	HP BASIC 4.0 statement	Effect on Model 7001
REN	REMOTE 7	Goes into effect when next addressed to listen.
IFC	ABORT 7	Goes into talker and listener idle states.
LLO	LOCAL LOCKOUT 7	LOCAL key locked out.
GTL	LOCAL 707	Cancel remote, restore front panel operation.
DCL	CLEAR 7	Returns 7001 to known conditions.
SDC	CLEAR 707	Returns all devices to known conditions.
GET	TRIGGER 707	Initiates a trigger.
SPE, SPD	SPOLL (707)	Serial Polls the Model 7001.

5.8.2 IFC (interface clear)

The IFC command is sent by the controller to place the Model 7001 in the local, talker, and listener idle states. The unit responds to the IFC command by cancelling front panel TALK or LISTEN lights, if the instrument was previously placed in one of those states.

Note that this command does not affect the status of the instrument; settings, data, and event registers are not changed.

To send the IFC command, the controller need only set the IFC line true for a minimum of 100μsec.

Programming Example — Before demonstrating the IFC command, turn on the TALK indicator with the following statement:

ENTER 707; A$

At this point, the TALK light should be on. The IFC command can be sent by entering the following statement into the computer:

ABORTIO 7

After the RETURN key is pressed, the TALK indicator turns off, indicating that the instrument has gone into the talker idle state.

5.8.3 LLO (local lockout)

The LLO command is used to prevent local operation of the instrument. After the unit receives LLO, all its front panel controls except POWER are inoperative. In this state, pressing LOCAL will not restore control to the front panel.

Programming Example — The LLO command is sent by entering the following statements:

REMOTE 707 LOCAL LOCKOUT 7

After the second statement is executed, the instrument's front panel controls are locked out, including the LOCAL key.

To restore front panel operation after asserting LLO, as in the following example, enter:

LOCAL 7

5.8.4 GTL (go to local) and local

The GTL command is used to take the instrument out of the remote state. Operation of the front panel keys will also be restored by GTL unless LLO is in effect. To cancel LLO, you must set REN false.

Programming Example — Place the instrument in the remote state with the following statement:

REMOTE 707

Now send GTL with the following statement:

LOCAL 707

Note that the instrument goes into the local state, and that operation of the front panel keys has now been restored (assuming that LLO is not in effect).

5.8.5 DCL (device clear)

The DCL command may be used to clear the Model 7001 and return it to a known state. Note that the DCL command is not an addressed command, so all instruments equipped to implement DCL will do so simultaneously.

When the Model 7001 receives a DCL command, it will clear the Input Buffer and Output Queue, cancel deferred commands, and clear any command that prevents the processing of any other device command. A DCL will not affect instrument settings, stored data, the channel list or scan list.

Programming Example — Use the following statement to perform a DCL:

```
CLEAR 7
```

When the RETURN key is pressed, the instrument will perform the DCL.

5.8.6 SDC (selective device clear)

The SDC command is an addressed command that performs essentially the same function as the DCL command. However, since each device must be individually addressed, the SDC command provides a method to clear only selected instruments instead of clearing all instruments simultaneously, as is the case with DCL.

Programming Example — Use the following statement to perform an SDC:

```
CLEAR 707
```

This sends the following IEEE-488 commands: UNT UNL LISTEN 07 SDC. When the statement is executed, the instrument performs the SDC.

5.8.7 GET (group execute trigger)

GET is a GPIB trigger that is used as an arm, scan and/or channel event to control the scanning process. The Model 7001 will react to this trigger if it is the programmed control source. The control source is programmed from the SCPI :TRIGger Subsystem (see paragraph 5.10.8).

With the instrument programmed and waiting for a GPIB trigger, the following programming statement will provide the GET:

```
TRIGGER 707
```

This sends IEEE-488 commands UNT UNL LISTEN 07 GET. When the ENTER key is pressed, the trigger event occurs. (The command TRIGGER 7 just sends GET. Any other listeners are triggered when the ENTER key is pressed.)

5.8.8 SPE, SPD (serial polling)

The serial polling sequence is used to obtain the Model 7001 serial poll byte. The serial poll byte contains important information about internal functions, as described in paragraph 5.6.8. Generally, the serial polling sequence is used by the controller to determine which of several instruments has requested service with the SRQ line. However, the serial polling sequence may be performed at any time to obtain the status byte from the Model 7001.

Programming Example — The SPOLL statement automatically performs the serial poll sequence. To demonstrate serial polling, enter in the following statements into the computer:

```
S=SPOLL (707)
PRINT "SPOLL BYTE =";S
```

After the first statement, the controller conducts the serial polling sequence. After the second statement is executed, the decimal value of the serial poll byte is displayed on the controller CRT.

5.9 Common commands

Common commands are device commands that are common to all devices on the bus. These commands are designated and defined by the IEEE-488.2 standard.

Table 5-5 summarizes the common commands used by the Model 7001 and are presented in alphabetical order. The following detailed descriptions include programming examples using HP BASIC 4.0.

Table 5-5
IEEE-488.2 common commands and queries

Mnemonic	Name	Description
*CLS	Clear status	Clears all event registers, and Error Queue.
*ESE <n>	Event status enable command	Sets the contents of the Standard Event Status Enable Register
*ESE?	Event status enable query	Request the programmed value of the Standard Event Status Enable Register.
*ESR?	Event status register query	Request the programmed value of the Standard Event Status Register and clears it.
*IDN?	Identification query	Request the manufacturer, model number, serial number, and firmware revision levels of the unit.
*OPC	Operation complete command	Sets the Operation Complete bit in the Standard Event Status Register after all pending commands have been executed.
*OPC?	Operation complete query	Places an ASCII "1" into the output queue when all pending selected device operations have been completed.
*OPT?	Option identification query	Request the assigned model number for each slot.
*RCL <n>	Recall command	Returns the Model 7001 to the setup configuration stored in the designated memory location.
*RST	Reset command	Returns the Model 7001 to the *RST default conditions.
*SAV <n>	Save command	Saves the current setup configuration to the designated memory location.
*SRE <n>	Service request enable command	Sets the contents of the Service Request Enable Register.
*SRE?	Service request enable query	The Model 7001 returns the value of the Service Request Enable Register.
*STB?	Read status byte query	Returns the value of the Status Byte Register.
*TRG	Trigger command	This command issues a bus trigger which has the same effect as group execute trigger (GET) command.
*TST?	Self-test query	When this query is sent, the Model 7001 will perform a checksum test on ROM and return the results.
*WAI	Wait-to-continue command	Wait until all previous commands are executed.

5.9.1 *CLS — clear status

Purpose

To clear status registers and error queue.

Format

*CLS

Description

The *CLS command is used to clear (reset to 0) the bits of the following registers in the Model 7001:

Standard Event Status Register
Operation Event Status Register
Error Queue
Trigger Event Status Register
Sequence Event Status Register
Arm Event Status Register

This command also forces the instrument into the operation complete command idle state and operation complete query idle state.

Programming example

```
OUTPUT 707; "*CLS"          ! Clear registers and Error Queue
```

5.9.2 *ESE — event status enable

Purpose To set the contents of the Standard Event Status Enable Register.

Format ***ESE <n>**

Parameters

n = 0	Clear (reset) register
n = 1	Set OPC (B0) of enable register
n = 4	Set QYE (B2) of enable register
n = 8	Set DDE (B3) of enable register
n = 16	Set EXE (B4) of enable register
n = 32	Set CME (B5) of enable register
n = 64	Set URQ (B6) of enable register
n = 128	Set PON (B7) of enable register

Defaults

Power-up	Clears register
*CLS	No effect
*RST	No effect
:STATus:PRESet	No effect
DCL, SDC	No effect

Description The *ESE command is used to set the contents of the Standard Event Status Enable Register. This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of the bits in the register.

This register is used as a mask for the Standard Event Status Register. When a standard event is masked, the occurrence of that event will not set the Event Summary Bit (ESB) in the Status Byte Register. Conversely, when a standard event is unmasked (enabled), the occurrence of that event will set the ESB bit. For information on the Standard Event Status Register and descriptions of the standard event bits, see paragraph 5.9.5. The Status Byte Register is described in paragraph 5.6.8.

A cleared bit (bit set to "0") in the enable register will prevent (mask) the ESB bit in the Status Byte Register from setting when the corresponding standard event occurs. A set bit (bit set to "1") in the enable register will allow (enable) the ESB bit to set when the corresponding standard event occurs. For details on the status register structure, refer to paragraph 5.6.

The Standard Event Status Enable Register is shown in Figure 5-13. Notice that the decimal weight of each bit is included in the illustration. The sum of the decimal weights of the bits that you wish to be set is the value that is sent with the *ESE command. For example, to set the CME and QYE bits of the Standard Event Status Enable Register, send the following command:

*ESE 36

where; CME (bit B5) = Decimal 32
QYE (bit B2) = Decimal 4
parameter = 36

If a command error (CME) occurs, bit B5 of the Standard Event Status Register will set. If a query error (QYE) occurs, bit B2 of the Standard Event Status Register will set. Since both of these events are unmasked (enabled), the occurrence of any one of them will cause the ESB bit in the Status Byte Register to set.

The contents of the Standard Event Status Event Register can be read by using the *ESE? query command (see next paragraph).

Programming example

```
OUTPUT 707; "*ESE 24"        ! Set bits B3 (EXE) and B4 (DDE) of the Standard
                               Event Status Enable Register.
```

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Event	PON	URQ	CME	DDE	EXE	QYE	—	OPC
Decimal Weighting	128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	— (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	—	0/1

Value : 1 = Enable Standard Event
0 = Disable (Mask) Standard Event

Events : PON = Power On
URQ = User Request
CME = Command Error
DDE = Device-dependent Error
EXE = Execution Error
QYE = Query Error
OPC = Operation Complete

Figure 5-13
Standard Event Status Enable Register

5.9.3 *ESE? — event status enable query

Purpose

To read the contents of the Standard Event Status Enable Register.

Format

***ESE?**

Description

This command is used to acquire the value (in decimal) of the Standard Event Status Enable Register. The binary equivalent of the decimal value determines which bits in the register are set. When the *ESE? query command is sent, the decimal value is placed in the Output Queue. When the Model 7001 is addressed to talk, the value is sent from the Output Queue to the computer.

For example, for an acquired decimal value of 48, the binary equivalent is 00110000. For this binary value, bits B4 and B5 of the Standard Event Status Enable Register are set. For information on the Standard Event Status Enable Register, refer to paragraph 5.6.1.

The *ESE? query command does not clear the Standard Event Status Enable Register.

Programming example

```
10 OUTPUT 707; "*ESE?"      ! Send query command
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display value of register contents
40 END
```

5.9.4 *ESR? — event status register query

Purpose To read the contents of the Standard Event Status Register and clear it.

Format *ESR?

Defaults

Power-up	Clears register
*CLS	Clears register
*RST	No effect
:STATus:PRESet	No effect
DCL, SDC	No effect

Descriptions This command is used to acquire the value (in decimal) of the Standard Event Status Register (see Figure 5-14). The binary equivalent of the returned decimal value determines which bits in the register are set. When the *ESR? command is sent, the decimal value is placed in the Output Queue and the Standard Event Status Register is cleared. When the Model 7001 is addressed to talk, the value in the Output Queue is sent to the computer.

A set bit in this register indicates that a particular event has occurred. For example, for an acquired decimal value of 48, the binary equivalent is 00110000. For this binary value, bits B4 and B5 of the Standard Event Status Register are set. These set bits indicate that a device-dependent error and command error have occurred.

The bits of the Standard Event Status Register are described as follows:

Bit B0, Operation Complete (OPC) — Set bit indicates that all pending selected device operations are completed and the Model 7001 is ready to accept new commands. This bit will only set in response to the *OPC? query command (see paragraph 5.9.7).

Bit B1 — Not Used

Bit B2, Query Error (QYE) — Set bit indicates that you attempted to read data from an empty Output Queue.

Bit B3, Device-dependent Error (DDE) — Set bit indicates that an instrument operation did not execute properly due to some internal condition.

Bit B4, Execution Error (EXE) — Set bit indicates that the Model 7001 detected an error while trying to execute a command.

Bit B5, Command Error (CME) — Set bit indicates that a command error has occurred. Command errors include:

1. IEEE-488.2 syntax error: Model 7001 received a message that does not follow the defined syntax of the IEEE-488.2 standard.

2. Semantic error: Model 7001 received a command that was misspelled, or received an optional IEEE-488.2 command that is not implemented.
3. The instrument received a Group Execute Trigger (GET) inside a program message.

Bit B6, User Request (URQ) — Set bit indicates that the LOCAL key on the Model 7001 front panel was pressed.

Bit B7, Power On (PON) — Set bit indicates that the Model 7001 has been turned off and turned back on since the last time this register has been read.

Programming example

```
10 OUTPUT 707; "*ESE?"      ! Request register value
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display value
```

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Event	PON	URQ	CME	EXE	DDE	QYE	—	OPC
Decimal Weighting	128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	— (2^1)	1 (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	—	0/1

Value : 1 = Event Bit Set
0 = Event Bit Cleared

Events : PON = Power On
URQ = User Request
CME = Command Error
EXE = Execution Error
DDE = Device-dependent Error
QYE = Query Error
OPC = Operation Complete

Figure 5-14
Standard Event Status Register

5.9.5 *IDN? — identification query

Purpose

To read the identification code of the Model 7001.

Format

*IDN?

Description

The *IDN? query command places the identification code of the Model 7001 in the Output Queue. When the Model 7001 is addressed to talk, the identification code will be sent to the computer.

The identification code includes the manufacturer, model number, serial number, and firmware revision levels, and is sent in the following format:

KEITHLEY INSTRUMENTS INC., MODEL 7001, ???????, ZZZZZZZZZ

where; ??????? is the serial number
ZZZZZZZZZ are the firmware revision levels of the digital board ROM and display board ROM

Programming example

```
10 OUTPUT 707; "*IDN?"      ! Request 7001 ID data
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display identification code
```

5.9.6 *OPC — operation complete

Purpose

To set the Operation Complete bit in the Standard Event Status Register after all pending commands are complete.

Format

*OPC

Description

After the *OPC command is sent, the Operation Complete bit (bit B0) of the Standard Event Status Register will set immediately after the last pending command is completed. If the corresponding bit (Bit 0) in the Standard Event Status Enable Register is set and Bit 5 (Event Summary Bit) of the Service Request Enable Register is set, the RQS/MSS (Request for Service/Master Summary Status) bit in the Status Byte Register will set.

When used with the Initiate Immediately command (:INITiate), the OPC bit of the Standard Event Status Register will not set until the Model 7001 goes back into the idle state to signal the end of a scan. The :INIT command operation is not considered finished until the Model 7001 goes back into the idle state.

Programming example

```
10  OUTPUT 707; ":open all"
20  OUTPUT 707; "*RST"
30  OUTPUT 707; ":scan (@ 1!1:1!10)"
40  OUTPUT 707; ":trig:coun:auto on"
50  OUTPUT 707; ":trig:del 0.5"
60  OUTPUT 707; ":init"
70  OUTPUT 707; "*OPC"
80  OUTPUT 707; "*ESR?"
90  ENTER 707; A$
100 PRINT A$
110 END
```

Line 10 Opens all channels.
Line 20 Selects default configuration (see Table 5-6)
Line 30 Defines scan list (channels 1 through 10).
Line 40 Enables automatic scan-list-length for channel count.
Line 50 Sets a 0.5 second delay between each channel.
Line 60 Starts the scan (takes 7001 out of idle state).
Line 70 Set OPC bit after the scan ends
Line 80 Request value of Standard Event Status Register.
Line 90 Address 7001 to talk.
Line 100 Display value of register (Bit 0 will be set).

When the above program is run, channels 1 through 10 will be scanned and then, at the end of the scan, Bit 0 in the Standard Event Status Register will set. The register is then read to verify that Bit 0 is set.

5.9.7 *OPC? — operation complete query

Purpose

Place a "1" in the Output Queue after all pending operations are completed.

Format

*OPC?

Description

When this common command is sent, an ASCII "1" will be placed in the Output Queue after the last pending operation is completed. When the Model 7001 is then addressed to talk, the "1" will be sent to the computer.

The "1" in the Output Queue will set the MAV (Message Available) bit (Bit 4) of the Status Byte Register. If the corresponding bit (Bit 4) in the Service Request Enable Register is set, the RQS/MSS (Request for Service/Master Summary Status) bit in the Status Byte Register will set.

When used with the Initiate Immediately command (:INITiate), a "1" will not be placed into the Output Queue until the Model 7001 goes back into the idle state (end of scan). The :INIT command operation is not considered finished until the Model 7001 goes back into the idle state.

Programming example

```
10  OUTPUT 707; ":open all"
20  OUTPUT 707; "*RST"
30  OUTPUT 707; ":scan (@ 1!1:1!10)"
40  OUTPUT 707; ":trig:coun:auto on"
50  OUTPUT 707; ":trig:del 0.5"
60  OUTPUT 707; ":init"
70  OUTPUT 707; "*OPC?"
80  ENTER 707; A$
90  PRINT A$
100 OUTPUT 707; "*STB?"
110 ENTER 707; B$
120 PRINT B$
130 END
```

Line 10 Opens all channels.
Line 20 Selects default configuration (see Table 5-6)
Line30 Defines scan list (channels 1 through 10).
Line 40 Enables automatic scan-list-length for channel count.
Line 50 Sets a 0.5 second delay between each channel.
Line 60 Starts the scan (takes 7001 out of idle state).
Line 70 Place a "1" in the Output Queue after the scan ends.
Line 80 Address the 7001 to talk
Line 90 Display the contents of the Output Queue ("1").
Line 100 Request value of Status Byte Register.
Line 110 Address 7001 to talk.
Line 120 Display value of register (Bit 4 will be set).

When the above program is run, channels 1 through 10 will be scanned and then, at the end of the scan, an ASCII "1" will be placed in the Output Queue. The Output Queue and Status Byte Register will then be read to verify the contents.

5.9.8 *OPT? — option identification query

Purpose

To read the identification code of optional switch cards installed in the Model 7001.

Format

***OPT?**

Description

The *OPT? query command places the option identification code in the Output Query. When the Model 7001 is addressed to talk, the code is sent from the Output Query to the computer.

The option identification code indicates the assigned model number for each slot of the mainframe. For example, if a Model 7011 and 7012 are installed in slots 1 and 2 respectively, the following message will be sent to the computer:

7011, 7012

Programming example

```
10 OUTPUT 707; "*OPT?"      ! Request option ID code
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display option ID code
```

5.9.9 *RCL — recall

Purpose

To return the Model 7001 to a setup configuration previously stored in memory.

Format

***RCL <n>**

Parameters

n = 0 to 9 Memory location

Description

The Model 7001 can store up to 10 setup configurations in memory locations 0 to 9. Over the bus, the *SAV command is used to save setup configurations (see paragraph 5.9.11).

The *RCL command is used to return the Model 7001 to a setup configuration stored at one of the memory locations. For example, if a setup configuration was previously stored at memory location 9, the Model 7001 can be returned to those setup conditions by sending the following command:

```
*RCL 9
```

Programming example

The following example assumes that a setup configuration has been stored at memory location 6 (see paragraph 5.9.11 for information on storing setup configurations).

```
OUTPUT 707; "*RCL 6"          ! Recall setup stored at memory location 6.
```

5.9.10 *RST — reset

Purpose

To reset the Model 7001.

Format

***RST**

Description

When the *RST command is sent, the Model 7001 performs the following operations:

1. Returns the Model 7001 to the *RST default conditions (see Table 5-6).
2. Cancels all pending commands.
3. Cancels response to any previously received *OPC and *OPC? commands.

The following instrument states are not affected by this command:

IEEE-488 address
Standard Event Status Register
Status Byte Register

Programming example

```
OUTPUT 707; "*RST"          ! Return 7001 to power-up defaults
```

Table 5-6
Default conditions

Command name	*RST value	:SYSTem:PRESet value
:INITiate		
:CONTinuous	OFF	OFF
:ARM		
:SEQuence[1]		
:LAYer[1]		
:COUNt	1	1
:SOURce	IMMediate	IMMediate
:TCONfigure		
:DIRection	ACCeptor	ACCeptor
:ASYNchronous		
:ILINe	1	1
:OLINe	2	2
:LAYer2		
:COUNt	1	INFinite
:DELay	0	0
:SOURce	IMMediate	IMMediate
:TIMer	0.001	0.001
:TCONfigure		
:DIRection	ACCeptor	ACCeptor
:ASYNchronous		
:ILINe	1	1
:OLINe	2	2
:TRIGger		
:SEQuence1		
:COUNt	1	Scan list length
:AUTO	OFF	ON
:DELay	0	0
:SOURce	IMMediate	MANual
:TIMer	0.001	0.001
:TCONfigure		
:PROTocol	ASYNchronous	ASYNchronous
:DIRection	ACCeptor	SOURce
:ASYNchronous		
:ILINe	1	1
:OLINe	2	2
:SSYNchronous		
:LINE	1	1
[:ROUTe]		
:CONFigure		
:SLOT[1]		
:STIMe	0	0
:SLOT2		
:STIMe	0	0
:CPAir	OFF	OFF
:SCHannel	OFF	OFF
:DISPlay		
:SMESsage	OFF	OFF

5.9.11 *SAV — save

Purpose

To save the current setup configuration in memory.

Format

***SAV <n>**

Parameters

n = 0 to 9 Memory location

Description

The Model 7001 can store up to 10 setup configurations at memory locations 0 to 9 by using the *SAV command. For example, to store the current setup configuration at memory location 6, send the following command:

```
*SAV 6
```

Table 5-7 lists the setup items (along with the bus commands to program them), that can be saved by the *SAV command.

Programming example

```
OUTPUT 707; "*SAV 6"          ! Store setup at memory location 6.
```

Table 5-7
**SAV and *RCL options*

Command name
:INITiate
:CONTinuous
:ARM
:SEQuence[1]
:LAYer[1]
:COUNt
:SOURce
:TCONfigure
:DIRection
:ASYNchronous
:ILINe
:OLINe
:LAYer2
:COUNt
:DELay
:SOURce
:TIMer
:TCONfigure
:DIRection
:ASYNchronous
:ILINe
:OLINe
:TRIGger
:SEQuence1
:COUNt
:AUTO
:DELay
:SOURce
:TIMer
:TCONfigure
:PROTocol
:DIRection
:ASYNchronous
:ILINe
:OLINe
:SSYNchronous
:LINE
[:ROUTe]
:CONFigure
:SLOT[1]
:STIMe
:SLOT2
:STIMe
:CPAir
:SCHannel
:DISPlay
:SMESsage

5.9.12 *SRE — service request enable

Purpose To set the contents of the Service Request Enable Register.

Format ***SRE <n>**

Parameters

n = 0	Clears enable register
n = 4	Set EAV bit (Bit 2)
n = 8	Set QSB bit (Bit 3)
n = 16	Set MAV bit (Bit 4)
n = 32	Set ESB bit (Bit 5)
n = 128	Set OSB bit (Bit 7)

Defaults

Power-up	Clears register
*CLS	No effect
*RST	No effect
:STATus:PRESet	No effect
DCL, SDC	No effect

Description The *SRE command is used to set the contents of the Service Request Enable Register. This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of each bit in the register.

This enable register is used along with the Status Byte Register to generate service requests (SRQ). With a bit in the Service Request Enable Register set, an SRQ will occur when the corresponding bit in the Status Byte Register is set by an appropriate event. For details on register structure, refer to paragraph 5.6.

The Service Request Enable Register is shown in Figure 5-15. Notice that the decimal weight of each bit is included in the illustration. The sum of the decimal weights of the bits that you wish to set is the value that is sent with the *SRE command. For example, to set the ESB and SSB bits of the Service Request Enable Register, send the following command:

*SRE 34

where;	ESB (bit B5) = Decimal	32
	MAV (bit B4) = Decimal	16
	parameter =	48

The contents of the Service Request Enable Register can be read using the *SRE? query command (see next paragraph).

Programming example

```
OUTPUT 707; "*SRE 32"          ! Set ESB bit
```

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Event	OSB	—	ESB	MAV	QSB	EAV	—	—
Decimal Weighting	128 (2^7)	— (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	— (2^1)	— (2^0)
Value	0/1	—	0/1	0/1	0/1	0/1	—	—

Value : 1 = Enable Service Request Event
0 = Disable (Mask) Service Request Event

Events : OSB = Operation Summary Bit
ESB = Event Summary Bit
MAV = Message Available
QSB = Questionable Summary Bit
EAV = Error Available

Figure 5-15
Service Request Enable Register

5.9.13 *SRE? — service request enable query

Purpose

To read the contents of the Service Request Enable Register.

Format

*SRE?

Description

The *SRE? command is used to acquire the value (in decimal) of the Service Request Enable Register. The binary equivalent of the decimal value determines which bits in the register are set. When the *SRE? query command is sent, the decimal value is placed in the Output Queue. When the Model 7001 is addressed to talk, the value is sent from the Output Queue to the computer.

For example, for an acquired decimal value of 17, the binary equivalent is 00010001. This binary value indicates that Bits 4 and 0 of the Service Request Enable Register are set (see previous paragraph).

Programming example

```
10 OUTPUT 707; "*SRE?"      ! Request contents of SRER
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display value register
```

5.9.14 *STB? — status byte query

Purpose To read the contents of the Status Byte Register.

Format *STB?

Description The *STB? query command is used to acquire the value (in decimal) of the Status Byte Register. The Status Byte Register is shown in Figure 5-16. The binary equivalent of the decimal value determines which bits in the register are set. The set bits in this register define the operating status of the Model 7001.

When the *STB? query command is sent, the decimal value is placed in the Output Queue. When the Model 7001 is addressed to talk, the value is sent from the Output Queue to the computer.

All bits, except Bit 6, in this register are set by other event registers and queues. Bit 6 sets when one or more enabled conditions occur.

The *STB? query command does not clear the status byte register. This register can only be cleared by clearing the related registers and queues. Register and queue structure are explained in paragraph 5.6.

For example, for an acquired decimal value of 48, the binary equivalent is 00110000. This binary value indicates that Bits 4 and 5 of the Status Byte Register are set.

The bits of the Status Byte Register are described as follows:

Bit 0 — Not used.
Bit 1 — Not used.

Bit 2, Error Available (EAV) — Set bit indicates that an error message is present in the Error Queue. The error message can be read using one of the following SCPI commands:

:SYSTem:ERRor?
:STATus:QUEue?

See paragraphs 5.10.7 and 5.10.6 for details.

Bit 3, Questionable Summary Bit (QSB) — Always zero (Questionable events not used by Model 7001).

Bit 4, Message Available (MAV) — Set bit indicates that a message is present in the Output Queue. The message is sent to the computer when the Model 7001 is addressed to talk.

Bit 5, Event Summary Bit (ESB) — Set bit indicates that an enabled standard event has occurred. The event can be identified by reading the Standard Event Status Register using the *ESE? query command (see paragraph 5.9.2).

Bit 6, Master Summary Status (MSS) / Request Service (RQS) — Set bit indicates that one or more enabled conditions have occurred to generate a service request (SRQ). Note that the IEEE-488.1 standard designates Bit 6 as the RQS bit and is read by performing a Serial Poll.

Bit 7, Operation Summary Bit (OSB) — Set bit indicates that an enabled operation event has occurred. The event can be identified by reading the Operation Event Status Register using the following SCPI command structure:

:STATus:OPERation?

See paragraph 5.10.6 for details.

Programming example

```
10 OUTPUT 707; "*SRE?"      ! Request contents of register
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display value of register
40 END
```

Bit Position	B7	B6	B5	B4	B3	B2	B1	B0
Event	OSB	MSS, RQS	ESB	MAV	QSB	EAV	—	—
Decimal Weighting	128 (2^7)	64 (2^6)	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	— (2^1)	— (2^0)
Value	0/1	0/1	0/1	0/1	0/1	0/1	—	—

Value : 1 = Event Bit Set
0 = Event Bit Cleared

Events : OSB = Operation Summary Bit
MSS = Master Summary Status
RQS = Request Service
ESB = Event Summary Bit
MAV = Message Available
QSB = Questionable Summary Bit
EAV = Error Available

Figure 5-16
Status Byte Register

5.9.15 *TRG — trigger

Purpose

To issue a GPIB trigger to the Model 7001.

Format

***TRG**

Description

The *TRG command is used to issue a GPIB trigger to the Model 7001. It has the same effect as a group execute trigger (GET).

The *TRG command is used as an arm, scan and/or channel event to control the scan cycle. The Model 7001 will react to this trigger if GPIB is the programmed control source. The control source is programmed from the SCPI :TRIGger Subsystem (see paragraph 5.10.8.

Programming example

```
OUTPUT 707; "*TRG"          ! Trigger 7001
```

5.9.16 *TST? — self-test query

Purpose

To run the self-tests and acquire the results.

Format

***TST?**

Description

The *TST? query command is used to perform a checksum test on ROM and places the coded result (0 or 1) in the Output Queue. When the Model 7001 is addressed to talk, the coded result is sent from the Output Queue to the computer.

A returned value of zero (0) indicates that the test passed, and a value of one (1) indicates that the test has failed.

Programming example

```
10 OUTPUT 707; "*TST?"      ! Run and request test result
20 ENTER 707; A$            ! Address 7001 to talk
30 PRINT A$                 ! Display coded result
```

5.9.17 *WAI — wait-to-continue

Purpose

To prevent the execution of further commands until all previous Overlapped commands are completed.

Format

***WAI**

Description

There are two types of device commands; Sequential commands and Overlapped commands. A Sequential command is a command whose operations are allowed to finish before the next command is executed. An Overlapped command is a command that allows the execution of subsequent commands while device operations of the Overlapped command are still in progress. The *WAI command is used to hold off the execution of subsequent commands until the device operations of Overlapped command are finished. The *WAI command is not needed for Sequential commands.

The Model 7001 uses only one Overlapped command; the Initiate Immediately command (:INITiate). The :INIT command takes the Model 7001 out of the idle state to enable the scan function. The device operations of the :INIT command are not considered complete until the Model 7001 goes back into the idle state. Typically, this occurs when all programmed scan operations are completed. By sending the *WAI command after the :INIT command, all subsequent commands will not execute until the Model 7001 goes back into the idle state.

Programming example

```
10  OUTPUT 707; ":open all"
20  OUTPUT 707; "*RST"
30  OUTPUT 707; ":scan (@ 1!1:1!10)"
40  OUTPUT 707; ":trig:coun:auto on"
50  OUTPUT 707; ":trig:del 0.5"
60  OUTPUT 707; ":init"
70  OUTPUT 707; "*WAI"
80  OUTPUT 707; ":clos (@ 1!11:1!20)"
90  END
```

Line 10 Opens all channels.
Line 20 Selects default configuration (see Table 5-6)
Line 30 Defines scan list (channels 1 through 10).
Line 40 Enables automatic scan-list-length for channel count.
Line 50 Sets a 0.5 second delay between each channel.
Line 60 Starts the scan (takes 7001 out of idle state).
Line 70 Wait until scan is finished.
Line 80 Close channels 11 through 20.

When the above program is run, channels 1 through 10 will be scanned and then, at the end of the scan, channels 11 through 20 will close. Without the *WAI command (Line 70), channels 11 through 20 will close at the same time that the scan starts.

5.10 SCPI command subsystems

SCPI commands are categorized into subsystems. The subsystems are presented in alphabetical order as follows:

5.10.1 **:DISPlay subsystem** — Explains the commands used to control user defined text messages.

5.10.2 **:OUTPut subsystem** — Explains the commands used to program the polarity (active-high or active-low) of the digital output port bits.

5.10.3 **:ROUTe subsystem** — Covers commands used to open and close channels, define a scan list, specify restricted (forbidden) channels, and enable/disable Single Channel and Card Pair. Also covered are slot configuration commands used to program the relay settling time, pole-mode and card type of each slot. Finally, memory commands used to store (save) and recall channel patterns are explained here.

5.10.4 **:SENSe subsystem** — Explains the command used to read the digital input port of the Model 7001.

5.10.5 **:SOURce subsystem** — Covers the commands used to set the state (0 or 1) of the digital output port bits.

5.10.6 **:STATus subsystem** — Covers the commands used to control the status registers of the Model 7001.

5.10.7 **:SYSTem subsystem** — Covers miscellaneous commands used to read the software revision level of the Model 7001, read the error queue, and set the power-on setup configuration.

5.10.8 **Trigger subsystem** — Covers commands used to scan.

5.10.1 :DISPlay subsystem

The display subsystem controls the display of the Model 7001 and is summarized in Table 5-8.

Table 5-8
DISPlay command summary

Command	Description
:DISPlay	
[:WINDow[1]]	Path to locate message to top portion of display
:TEXT	Path to control user text messages:
:DATA <a>	Define ASCII message "a" using up to 20 characters.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message.
:STATe?	Request message status (enabled or disabled).
:WINDow2	Path to locate message to bottom portion of display:
:TEXT	Path to control user text messages:
:DATA <a>	Define ASCII message "a" using up to 32 characters.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message.
:STATe?	Request message status (enabled or disabled).
:SMESsage <b>	Enable (1 or ON) or disable (0 or OFF) displayed status messages.
:SMESsage?	Request state of status message display.

Note: Command shortform is indicated by upper case characters. For example, instead of sending "display:text :state on", you can send "disp:text:stat on".

[:WINDow[1]]

:DISPlay[:WINDow[1]]

This command path is used to control the top portion of the display. The brackets "[]" enclosing this command indicate that it is implied and can be disregarded.

:TEXT

:DISPlay[:WINDow[1]]:TEXT

This command path is used to control user text messages for the top portion of the Model 7001 display. The Model 7001 uses the following commands in this path:

:DATA <a>

:DISPlay[:WINDow[1]]:TEXT:DATA <a>

Parameter

a = ASCII character for message.

Formats

String	:disp:text:data	'aa...a'
Indefinite block	:disp:text:data	#0aa...a
Definite block	:disp:text:data	#XYaa...a

where; Y = number of characters in message (1-20).
X = number of digits that make up Y (1 or 2)

Defaults

Power-up	Cancels message
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command defines the text message that you wish to display. The message can be as long as 20 characters. A space is counted as a character. Excess message characters (over 20) are simply ignored.

An indefinite block message must be the only command in the program line or the last command in the program line. If you include a command after an indefinite block message (on the same line), it will be treated as part of the message and will be displayed instead of executed.

:STATe <b>

:DISPlay[:WINDow[1]]:TEXT:STATe <b>

Parameters

b = 0 or OFF	Disable text message
b = 1 or ON	Enable text message

Format

:disp:text:stat b

Defaults

Power-up	Disables message
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command enables or disables the text message that was last defined using "data". When enabled, the message will be shown on the upper portion of the Model 7001 display. When disabled, the message will be cancelled.

The text message can be enabled even it there is no message defined (see previous command). While enabled, the message will be displayed as soon as it is defined.

A user defined text message remains displayed only as long as the instrument is in remote. Taking the instrument out of remote (by pressing the LOCAL key or sending LOCAL 707), disables the text message.

:STATe?

:DISPlay[:WINDow[1]]:TEXT:STATe?

Format

:disp:text:stat?

Description

This query command is used determine the message display state of the upper portion of the display. After sending this command, addressing the Model 7001 to talk will send back a value that indicates status.

"0" indicates that the message display state is disabled, while a "1" indicates that the message display state is enabled.

:WINDow2

:DISPlay:WINDow2

This command path is used to control the bottom portion of the display. The following path and commands are used in this path:

:TEXT

:DISPlay:WINDow2:TEXT

This command path is used to control user text messages for the bottom portion of the Model 7001 display. The Model 7001 uses the following commands in this path:

:DATA <a>

:DISPlay:WINDow2:TEXT:DATA <a>

Parameter

a = ASCII character for message.

Formats

String	disp:wind2:text:data	'aa...a'
Indefinite Block	disp:wind2:text:data	#0aa...a
Definite Block	disp:wind2:text:data	#XYaa...a

where; Y = number of characters in message (1-32).
X = number of digits that make up Y (1 or 2)

Defaults

Power-up	Cancels message
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command defines the text message that you wish to display. The message can be as long as 32 characters. A space is counted as a character. Excess message characters (over 32) are simply ignored.

An indefinite block message must be the only command in the program line or the last command in the program line. If you include a command after an indefinite block message (on the same line), it will be treated as part of the message and will be displayed instead of executed.

:STATe <b>

:DISPlay:WINDow2:TEXT:STATe <b>

Parameters

b = 0 or OFF	Disable text message
b = 1 or ON	Enable text message

Format

:disp:wind2:text:stat b

Defaults

Power-up	Cancels message
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command enables or disables the text message that was last defined using "data". When enabled, the message will be shown on the bottom portion of the Model 7001 display. When disabled, the message will be cancelled.

Text message can be enabled even it there is no message defined (see previous command). While enabled, the message will be displayed as soon as it is defined.

A user defined text message remains displayed only as long as the instrument is in remote. Taking the instrument out of remote (by pressing the LOCAL key or sending LOCAL 707), disables the text message.

:STATe?

:DISPlay:WINDow2:TEXT:STATe?

Format

:disp:wind2:text:stat?

Description

This query command is used determine the message display state of the upper portion of the display. After sending this command, addressing the Model 7001 to talk will send back a value that indicates status.

"0" indicates that the message display state is disabled, while a "1" indicates that the message display state is enabled.

:SMESsage <b>

:DISPlay:SMESsage <b>

Parameters

b = 0 or OFF	Disable status messages
b = 1 or ON	Enable status messages

Format

:disp:smes b

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Disables status messages
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Disables status messages
:STATus:PRESet	No effect

Description

This command is used to enable/disable the status message mode for the Model 7001. The status message mode is a diagnostic tool that provides real-time messages that relate to the current operating state of the instrument. See Table 5.3 for a list of status messages.

:SMESsage?

:DISPlay:SEMSsage?

Format

:disp:smes?

Description

This query command is used to request the state of the status message display. After sending this command and addressing the Model 7001 to talk, the status message (0 or 1) will be sent to the computer.

Programming example

The following programming example will demonstrate how to use the commands of the DISPlay subsystem to display a user defined message:

```
10  OUTPUT 707; ":disp:text:data 'Keithley Model 7001'; stat on; stat?"
20  ENTER 707; A$
30  PRINT "Top message display status = "; A$
40  OUTPUT 707; ":disp:wind2:text:data ' Switch System'; stat on; stat?"
50  ENTER 707; B$
60  PRINT "Bottom message display status = "; B$
70  END
```

Line 10 Three commands on this line to control the top display. DATA defines the message, STATe displays the message, and STATe? requests the status of the message display.

Line 20 Addresses the 7001 to talk.

Line 30 Displays (on the CRT) the status of the message display (1; enabled).

Line 40 Three commands on this line to control the bottom display. DATA defines the message, STATe displays the message, and STATe? requests the status of the message display.

Line 50 Addresses the 7001 to talk.

Line 60 Displays (on the CRT) the status of the message display (1; enabled).

5.10.2 :OUTPut subsystem

The OUTPut subsystem is used to set polarities for the digital output port. Commands in this subsystem are summarized in Table 5-9.

Table 5-9
OUTPut command summary

Command	Description
:OUTPut	
:TTLn	Path and command to specify output line "n" (1-4):
:LSENse AHIGh | ALOW	Set polarity; active high (AHIG) or active low (ALOW).
:LSENse?	Request polarity of specified output line (n).

Note: Command shortform is indicated by uppercase characters. For example, instead of sending ":output:ttl1:lsense ahigh", you can send ":outp:ttl1:lsen ahig".

:TTLn

:OUTPut:TTLn

Parameters

n = 1 Output line 1 (Bit 1)
n = 2 Output line 2 (Bit 2)
n = 3 Output line 3 (Bit 3)
n = 4 Output line 4 (Bit 4)

Description

This command path is used to set (and query) the polarity of the specified digital output line (n). The following commands are used in this path:

LSENse AHIGh | ALOW

:OUTPut:TTLn:LSENse AHIGh|ALOW

Parameters

AHIGh Set specified output to active high
ALOW Set specified output to active low

Formats

:outp:ttln:lsen ahig
:outp:ttln:lsen alow

Defaults

Power-up	Sets all bits for active high polarity
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command sets the polarity of the specified output line "n". When an output line (bit) is programmed for active high (ahig), the "1 or ON" output level is +5V, and the

"0 or OFF" output level is 0V. Conversely, when programmed for output low (alow), the "1 or ON" output level is 0V, and the "0 or OFF" output level is +5V.

The bits of the output port are programmed ("0 or OFF" or "1 or ON") using the SOURce subsystem (see paragraph 5.10.5).

:LSENse?

:OUTPut:TTLn:LSENse?

Format

outp:ttln:lsen?

Description

This query command is used to request the polarity of the specified digital output line (n). After sending this command and addressing the Model 7001 to talk, a message that defines polarity will be sent to the computer. The message "AHIG" indicates active high polarity, and the message "ALOW" indicates active low polarity.

Programming example

The following example demonstrates how to use the command of the OUTPut subsystem:

```
10 OUTPUT 707; ":outp:ttl1:lsen alow;lsen?"
20 ENTER 707; A$
30 PRINT A$
40 END
```

Line 10 Three commands on this line; TTL specifies output line 1, LSENse sets polarity to active low, and LSENse? requests the polarity.

Line 20 Addresses the 7001 to talk.

Line 30 Displays the polarity message on the CRT.

5.10.3 [:ROUTe] subsystem

The ROUTe subsystem is used to control signal routing through the switch system and is summarized in Table 5-10. The brackets indicate that this command is optional and need not be included in the command message.

Table 5-10
ROUTe command summary

Command	Description
[:ROUTe]	
:CLOSe <list>	Path and command to close specified channels:
:STATe?	Request channels that are closed.
:OPEN <list> | ALL	Open specified (or all) channels.
:SCAN <list>	Path and command to specify channel list:
:POINts?	Request number of channels in the scan list.
:SCAN?	Request the programmed scan list.
:FCHannels <list>	Specifies channels that cannot be closed (forbidden).
:FCHannels?	Request list of restricted channels.
:CONFigure:	Configuration command path:
:SCHannel <b>	Enable (1 or ON) or disable (0 or OFF) Single Channel.
:SCHannel?	Request status of Single Channel mode.
:CPAir <b>	Enable (1 or ON) or disable (0 or OFF) Channel Pairing.
:CPAir?	Request status of Channel Pairing.
:SLOT1	Path to configure CARD 1:
:CTYPE <type>	Specify the card type installed in the slot.
:CTYPE?	Request the card type installed in the slot.
:POLE <n>	Select pole mode (1, 2 or 4).
:POLE?	Request the programmed number of poles.
:STIMe <num>	Set relay settling time in seconds (0 to 99999.999).
:STIMe?	Request the programmed relay settling time.
:SLOT2	Path to configure CARD 2:
:CTYPE <type>	Specify the card type installed in the slot.
:CTYPE?	Request the card type installed in the slot.
:POLE <n>	Select pole mode (1, 2 or 4).
:POLE?	Request the programmed number of poles.
:STIMe <num>	Set relay settling time in seconds (0 to 99999.999).
:STIMe?	Request the programmed relay settling time.
:MEMory	Path to program memory:
:SAVe M<num>	Saves channel pattern at memory location (1-100).
:RECall M<num>	Recalls channel pattern from memory location (1-100).

Note: Command shortform is indicated by upper case characters. For example, instead of sending ":configure :schannel?", you can send ":conf:sch?".

:CLOSe <list>

[:ROUTe]:CLOSe <list>

Parameter

list = (@ chanlist)

where; chanlist is the specified list of channels (channel list) to be closed.

Format

:clos (@ chanlist)

Defaults

Power-up	All channels open
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

Close serves as a command path and is used to close the specified channels when the <list> parameter is included. The chanlist (channel list) specifies the channel or channels to close. The following examples demonstrate various forms for expressing channel entries for a chanlist.

Chanlist	
= 1!2!4	Single channel (Slot 1, Row 2, Column 4).
= 2!36	Single channel (Slot 2, Channel 36).
= 1!6, 1!18, 2!3!6	Multiple channels separated by commas.
= 1!2:1!10	Range of channels (2 through 10).
= 1!2:1!10, 2!3!6	Range entry and single entry separated by commas.
= 1!30:1!40, 2!1:2!10	Range of multiplex channels (last 10 channels on card 1, first 10 channels on card 2).
= 1!4!1:1!4!10, 2!1!1:2!4!10	Range of matrix channels (10 columns of row 4 on card 1, 10 columns of row 1 on card 2).
= M36	Channel pattern stored at memory location M36.

Note: If using this command exclusively as a path, the <list> parameter is not used.

:STATe?

[:ROUTe]:CLOSe:STATe?

Format

:clos:stat?

Description

This query command is used to request the channels that are currently closed. For example if channels 1!2!3 and 2!36 are closed, the following message will be sent to the computer after sending this command and addressing the Model 7001 to talk:

(@1!2!3, 2!36)

Programming example

This programming example demonstrates how to use the CLOSe and STATe? commands of the ROUTe subsystem.

```
10  OUTPUT 707; ":clos (@ 1!1, 1!5:1!10); clos:stat?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 10 Two commands on this line. CLOSe closes the listed channels and STATe? requests the list of closed channels.
Line 20 Addresses the Model 7001 to talk.
Line 30 Displays (on the CRT) the list of closed channels.

:OPEN <list> | ALL

[:ROUTe]:OPEN <list>|ALL

Parameter

list = (@ chanlist)

ALL is used to open all channels

where; chanlist is the specified list of channels (channel list) to be opened.

Formats

:open (@ chanlist)
:open all

Defaults

Power-up	All channels open
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command is used to open channels specified by the parameter. The <list> parameter is used to specify a chanlist (channel list) and the ALL parameter is used to open all channels.

The following examples demonstrate various forms for expressing channel entries for a chanlist.

Chanlist

= 1!2!4	Single channel (Slot 1, Row 2, Column 4).
= 2!36	Single channel (Slot 2, Channel 36).
= 1!6, 1!18, 2!3!6	Multiple channels separated by commas.
= 1!2:1!10	Range of channels (2 through 10).
= 1!2:1!10, 2!3!6	Range entry and single entry separated by commas.
= 1!30:1!40, 2!1:2!10	Range of multiplex channels (last 10 channels on card 1, first 10 channels on card 2).
= 1!4!1:1!4!10, 2!1!1:2!4!10	Range of matrix channels (10 columns of row 4 on card 1, 10 columns of row 1 on card 2).
= M36	Channel pattern stored at memory location M36.

Programming example

The following programming example demonstrates how to use the OPEN command of the ROUTe subsystem:

```
10  OUTPUT 707; ":clos (@ 1!1:1!10)"
20  OUTPUT 707; ":open (@ 1!1:1!6)"
30  WAIT 3
40  OUTPUT 707; ":open all"
50  END
```

Line 10 Closes channels 1 through 10 of Slot 1 (see CLOSe command).
Line 20 Opens channels 1 through 6.
Line 30 Three second delay.
Line 40 After waiting three seconds, the rest of the channels (7-10) open.

:SCAN <list>

[:ROUTe]:SCAN <list>

Parameter

list = (@ scanlist)

where; scanlist is the specified list of channels (scan list) to be scanned.

Format

:scan (@ scanlist)

Defaults

Power-up	Last defined scan list
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

Scan is used as a command path and, when used with the parameter, a command to define a scan list. The scanlist specifies the channel or channels to scan. The following examples demonstrate various forms for expressing a scanlist:

Scanlist

= 1!6, 1!18, 2!3!6	Channels separated by commas.
= 1!2:1!10	Range of channels (2 through 10).
= 1!10:1!2	Range of channels (10 through 2).
= 1!2:1!10, 1!20	Range entry and single entry separated by commas.
= 1!30:1!40, 2!1:2!10	Range of multiplex channels (last 10 channels on card 1, first 10 channels on card 2).
= 1!4!1:1!4!10, 2!1!1:2!4!10	Range of matrix channels (10 columns of row 4 on card 1, 10 columns of row 1 on card 2).
= M36	Channel pattern stored at memory location M36.

Note: When using this command exclusively as a path, the parameter is not used.

:POINts?

[:ROUTe]:SCAN:POINts?

Format

:scan:poin?

Description

This query command is used to request the number of channels in the scan list. A channel pattern (i.e. M1) in the scan list is counted as one channel. For example, assume the following scan list:

(@ 1!1:1!5, 1!10, M2)

After the poin? command is sent and the Model 7001 is address to talk, the following message will be sent to the computer:

7

The "7" indicates that there are seven channels in the scan list.

Programming example

The following programming example demonstrates how to use the SCAN and POINts? commands of the ROUTe subsystem:

```
10 OUTPUT 707; ":scan (@1!2, 1!4); scan:poin?"
20 ENTER 707; A$
30 DISP A$
40 END
```

Line 10 Two commands on this line; SCAN creates a scan list and POINts? requests the number of channels in the scan list.

Line 20 Addresses the 7001 to talk.

Line 30 Displays (on the CRT) the number of channels (2) in the scan list.

:SCAN?

[:ROUTe]:SCAN?

Format

:scan?

Description

This query command is used to request the currently defined scan list. After sending this command, the scan list is sent to the computer when the Model 7001 is addressed to talk. An example of a returned scan list is shown as follows:

(@1!1:1!5, 1!8)

The above scan list consists of channels 1, 2, 3, 4, 5, and 8 (all for slot 1). If a scan list does not exist (cleared), the scan? query command will send the following message:

(@)

Programming example

The following programming examples demonstrate how to use the SCAN? command of the ROUTe subsystem.

Example #1:

```
10  OUTPUT 707; ":scan?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 10 Requests scan list.
Line 20 Addresses 7001 to talk.
Line 30 Displays scan list on the CRT.

Example #2:

```
10  OUTPUT 707; ":scan (@ 1!1:1!5, 1!8); scan?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 10 Two commands on this line; SCAN defines a scan list and SCAN? requests the scan list.
Line 20 Addresses 7001 to talk.
Line 30 Displays scan list on the CRT.

:FCHannels <list>

[:ROUTe]:FCHannels <list>

Parameter

list = (@ forblist)

where; forblist is the specified list of "forbidden" channels that cannot be closed.

Format

:fch (@ forblist)

Defaults

Power-up	Last defined forbidden channel list
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command, along with its parameter, is used to define a list of channels that cannot be closed. The following examples demonstrate various forms for expressing a forblist:

Forblist	= 1!1	Single channel (Slot 1, Channel 1).
	= 1!6, 1!18, 2!3!6	Channels separated by commas.
	= 1!2:1!10	Range of channels (2 through 10).
	= 1!2:1!10, 1!20	Range entry and single entry separated by commas.
	= M36	Channel pattern stored at memory location M36.

A "forbidden" channel list can be cancelled by sending an empty forblist as follows:

:fch (@)

Programming example

The following programming statement defines a "forbidden" channel list that consists of channels 1!1 and 1!4:

OUTPUT 707; ":fch (@ 1!1, 1!4)"

:FCHannels?

[:ROUTe]:FCHannels?

Format

:fch?

Description

This query command is used to request the list of "forbidden" channels. These restricted channels cannot be closed. After sending this command, addressing the Model 7001 to talk will send back the restricted channel list. For example, if Channels 1!1 and 1!4 are restricted, the following message will be sent to the computer:

(@1!1, 1!4)

If there are no restricted channels currently defined, the following message will be sent:

(@)

Programming example

The following programming examples will demonstrate how to use the FCHannels? command of the ROUTe subsystem.

Example #1:

```
10  OUTPUT 707; ":fch?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 10 Requests "forbidden" channel list.
Line 20 Addresses 7001 to talk.
Line 30 Displays the restricted channel list on the CRT.

Example #2:

```
10  OUTPUT 707; ":fch (@ 1!1, 1!4); fch?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 10 Two commands on this line; FCHannels creates a restricted channel list and FCHannels? requests the list.
Line 20 Addresses 7001 to talk.
Line 30 Displays the restricted channel list on the CRT.

:CONFigure

[:ROUTe]:CONFigure

This command path is used to configure the slots of the Model 7001. It is also used to control the Card Pairing feature and the Single Channel mode of the instrument. The following commands are used in this path:

:SCHannel <b>

[:ROUTe]:CONFigure:SCHannels <b>

Parameters

b = 0 or OFF Disable the Single Channel mode.
b = 1 or ON Enable the Single Channel mode.

Format

:conf:sch b

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Disables Single Channel
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Disables Single Channel
:STATus:PRESet	No effect

Description

The Single Channel mode (when enabled) is used to prevent more than one channel from closing at a time. When a single channel is closed, the previous closed channel will open. This ensures that even with random channel closures, only one channel can be closed at a time. When the Single Channel mode is enabled, all channels are opened. For complete details on Single Channel, see Section 4.

:SCHannel?

[:ROUTe]:CONFigure:SCHannels?

Format

:conf:sch?

Description

This query command is used to request the status of the Single Channel mode. After this command is sent and the Model 7001 is addressed to talk, a value (0 or 1) is sent to the computer.

A "0" indicates that Single Channel is disabled and a "1" indicates that Single Channel is enabled.

:CPAir <b>

[:ROUTe]:CONFigure:CPair <b>

Parameters

b = 0 or OFF Disable Card Pair.

b = 1 or ON Enable Card Pair.

Format

:conf:cpa b

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Disables Card Pair
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Disables Card Pair
:STATus:PRESet	No effect

Description

With Card Pair enabled, the corresponding channels of the two cards installed in the mainframe are controlled concurrently. Both cards become assigned to slot 1. For example, closing channel 10 of CARD 1, will also close channel 10 of CARD 2.

Card Pair can only be enabled for similar type cards. For example, you will not be able to enable Card Pair if a multiplexer card is installed in one slot and a matrix card is installed in the other slot.

:CPAir?

[:ROUTe]:CONFigure:CPAir?

Format

:conf:cpa?

Description

This query command is used to request the status of the Card Pair feature. After sending this command, the status (0 or 1) is sent to the computer when the Model 7001 is addressed to talk. A "0" indicates that Card Pair is disabled, and a "1" indicates that Card Pair is enabled.

:SLOT1

[:ROUTe]:CONFigure:SLOT1

This path is used to configure Slot 1 for proper operation. The following commands are used in this path:

:CTYPE <type>

[:ROUTe]:CONFigure:SLOT1:CTYPE <type>

Parameters

type = C7052	type = C7062	type = C7154	type = C9991
type = C7053	type = C7063	type = C7156	type = C9990
type = C7054	type = C7064	type = C7158	
type = C7056	type = C7065	type = C7164	
type = C7057	type = C7066	type = C7166	
type = C7058	type = C7067	type = C7168	

type = C7059 type = C7152 type = C7169
type = C7061 type = C7153 type = C7402

Format

```
:conf:slot1:ctype type
```

Defaults

Power-up	Senses 701X card or uses last programmed type
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

When a Model 701X series card (i.e. Model 7011, 7012 or 7013) is not installed in Slot 1, use this command to assign the appropriate model number to it. For example, if a Model 7156 card is installed in Slot 1, use type parameter C7156.

C9990 and C9991 are card simulators. By assigning C9990 to Slot 1, the instrument will operate as if a 40 channel switch card is installed. By assigning C9991, the instrument will operate as if a 4 × 10 matrix is installed.

:CTYPE?

[:ROUTe]:CONFigure:SLOT1:CTYPE?

Format

```
:conf:slot1:ctype?
```

Description

This query command is used to request the model number assignment for Slot 1. After sending this command, the model number is sent to the computer when the Model 7001 is addressed to talk. For example, if the Model 7156 scanner card is assigned to Slot 1, the following message will be sent:

7156

:POLE <n>

[:ROUTe]:CONFigure:SLOT1:POLE <n>

Parameters

n = 1 Select 1-pole mode
n = 2 Select 2-pole mode
n = 4 Select 4-pole mode

Format

```
:conf:slot1:pole n
```

Defaults

Power-up	Last selected pole mode
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect

:STATus:PRESet No effect

Description

Some cards have the capability to operate as more than one switch type. For example, the Model 7011 multiplexer card can be used for 40-channel, 2-pole switching, or for 20-channel, 4-pole switching.

The switch cards that have an additional pole mode capability are summarized as follows:

	Pole Mode		
Card	1-Pole	2-pole	4-pole
7011	N/A	40 channels	20 channels
7056	20 channels	10 channels	N/A
7156	20 channels	10 channels	N/A

Keep in mind that the card must be wired appropriately for the selected pole mode. For more information on Pole-Mode, see Section 4 of this manual.

The factory default is the 2-pole mode for all cards. This command is used to select an alternate pole mode for the card installed in slot 1. An invalid pole mode cannot be selected and will result in an error message.

:POLE?

[:ROUTe]:CONFigure:SLOT1:POLE?

Format

:conf:slot1:pole?

Description

This query command is used to request the currently selected pole mode for the card in slot 1. After sending this command, the pole mode (1, 2 or 4) is sent to the computer when the Model 7001 is addressed to talk.

"1" indicates that the 1-pole mode is selected, "2" indicates that the 2-pole mode is selected, and "4" indicates that the 4-pole mode is selected.

:STIMe <num>

[:ROUTe]:CONFigure:SLOT1:STIMe <num>

Parameter

num = settling time for CARD 1 in seconds (0 to 99999.999 seconds).

Format

:conf:slot1:stim num

Defaults

Power-up	Delay = 0 sec
*RST	Delay = 0 sec
*CLS	No effect
DCL, SDC	No effect

:SYSTem:PRESet	Delay = 0 sec
:STATus:PRESet	No effect

Description

An internally set relay settling time is provided to allow for switch bounce when it closes. At power-up, a settling time is automatically set based on the acquired identification information. This command allows you to increase the delay for the card (CARD 1) in slot 1.

The delay value can be entered using the exponent form. For example, instead of sending a parameter value of 2000 (seconds), you can instead send 2E3. To cancel this delay, send this command using a parameter value of 0. For complete information on this delay, see DELAY in paragraph 2.7.

:STIMe?

[:ROUTe]:CONFigure:SLOT1:STIMe?

Format

:conf:slot1:stim?

Description

This query command is used to request the settling time for CARD 1. After sending this command, the settling time is sent to the computer when the Model 7001 is addressed to talk. For example, if the settling time is 2.25 seconds, the following message will be sent:

2.250

:SLOT2

[:ROUTe]:CONFigure:SLOT2

This path is used to configure Slot 2 for proper operation. The following commands are used in this path:

:CTYPE <type>

[:ROUTe]:CONFigure:SLOT2:CTYPE <type>

Parameters

type = C7052	type = C7062	type = C7154	type = C9991
type = C7053	type = C7063	type = C7156	type = C9990
type = C7054	type = C7064	type = C7158	
type = C7056	type = C7065	type = C7164	
type = C7057	type = C7066	type = C7166	
type = C7058	type = C7067	type = C7168	
type = C7059	type = C7152	type = C7169	
type = C7061	type = C7153	type = C7402	

Format

:conf:slot2:ctype type

Defaults

Power-up	Senses 701X card or uses last programmed type
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

When a Model 701X series card (i.e. Model 7011, 7012 or 7013) is not installed in Slot 2, use this command to assign the appropriate model number to it. For example, if a Model 7156 card is installed in Slot 2, use type parameter C7156.

C9990 and C9991 are card simulators. By assigning C9990 to Slot 2, the instrument will operate as if a 40-channel switch card is installed. By assigning C9991, the instrument will operate as if a 4 × 10 matrix is installed.

:CTYPE?

[:ROUTe]:CONFigure:SLOT2:CTYPE?

Format

:conf:slot2:ctype?

Description

This query command is used to request the model number assignment for Slot 2. After sending this command, the model number is sent to the computer when the Model 7001 is addressed to talk. For example, if the Model 7156 scanner card is assigned to Slot 2, the following message will be sent:

C7156

:POLE <n>

[:ROUTe]:CONFigure:SLOT2:POLE <n>

Parameters

n = 1 Select 1-pole mode
n = 2 Select 2-pole mode
n = 4 Select 4-pole mode

Format

:conf:slot2:pole n

Defaults

Power-up	Last selected pole mode
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

Some cards have the capability to operate as more than one switch type. For example, the Model 7011 multiplexer card can be used for 40-channel, 2-pole switching, or for 20-channel, 4-pole switching.

The switch cards that have an additional pole mode capability are summarized as follows:

	Pole Mode		
Card	1-pole	2-pole	4-pole
7011	N/A	40 channels	20 channels
7056	20 channels	10 channels	N/A
7156	20 channels	10 channels	N/A

Keep in mind that the card must be wired appropriately for the selected pole mode. For more information on Pole Mode, see Section 4 of this manual.

The factory default is the 2-pole mode for all cards. This command is used to select an alternate pole mode for the card installed in slot 2. An invalid pole mode cannot be selected and will result in an error message.

:POLE?

[:ROUTe]:CONFigure:SLOT2:POLE?

Format

:conf:slot2:pole?

Description

This query command is used to request the currently selected pole mode for the card in slot 2. After sending this command, the pole mode (1, 2 or 4) is sent to the computer when the Model 7001 is addressed to talk.

"1" indicates that the 1-pole mode is selected, "2" indicates that the 2-pole mode is selected, and "4" indicates that the 4-pole mode is selected.

:STIMe <num>

[:ROUTe]:CONFigure:SLOT2:STIMe <num>

Parameter

num = settling time for CARD 2 in seconds (0 to 99999.999 seconds).

Format

:conf:slot2:stim num

Defaults

Power-up	Delay = 0 sec
*RST	Delay = 0 sec
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Delay = 0 sec
:STATus:PRESet	No effect

Description

An internally set relay settling time is provided to allow for switch bounce when it closes. At power-up, the settling time is automatically set based on the acquired identifica-

tion information. This command allows you to increase the delay for the card (CARD 2) in slot 2.

The delay value can be entered using the exponent form. For example, instead of sending a parameter value of 2000 (seconds), you can instead send 2E3. To cancel this delay, send this command using a parameter value of 0. For complete information on this delay, see DELAY in paragraph 2.7.

:STIMe?

[:ROUTe]:CONFigure:SLOT2:STIMe?

Format

:conf:slot2:stim?

Description

This query command is used to request the settling time for CARD 2. After sending this command, the settling time is sent to the computer when the Model 7001 is addressed to talk. For example, if the settling time is 2.25 seconds, the following message will be sent:

2.250

Programming example

The following programming example will demonstrate the use of the CONFigure commands of the ROUTe system:

```
10  OUTPUT 707; ":conf:sch on;cpa off;slot1:stim 1"
20  OUTPUT 707; ":conf:sch?;cpa?;slot1:stim?;pole?"
30  ENTER 707 A$
40  PRINT A$
50  END
```

Line 10 Three commands on this line; SCHannel enables Single Channel, CPAir disables Card-Pair, and STIMe sets Slot 1 delay for one second.

Line 20 Four query commands on this line; SCHannel? requests the status of Single Channel, CPAir? requests the status of Card-Pair, POLE? requests the Pole-Mode for Slot 1, and STIMe? requests the delay for Slot 1.

Line 30 Addresses 7001 to talk; all query data is sent to computer.

Line 40 Displays query messages on CRT. Data displayed in order that the queries were sent. For example:

1, 0, 1.000, 2

"1" indicates that Single Channel is enabled, "0" indicates that Card-Pair is disabled, "1.000" indicates that the delay is set for one second, "2" indicates that slot 1 is configured for 2-pole operation.

:MEMory

[:ROUTe]:MEMory

This command path is used to save (store) channel patterns in memory and to recall them. The following commands are in this path:

:SAVe M<num>

[:ROUTe]:MEMory:SAVe M<num>

Parameter num = 1 to 100

M is the memory location designator

Format :mem:sav Mnum

Description This command is used to save (store) a channel pattern to a memory location. You can save up to 100 channel patterns in memory locations 1 to 100.

A channel pattern can be recalled from memory using the RECall command (see next command).

Defaults

Power-up	No effect
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

:RECall M<num>

[:ROUTe]:MEMory:RECall M<num>

Parameter num = 1 to 100

M is the memory location designator

Format :mem:rec Mnum

Description This command is used to recall a channel pattern stored in a memory location. Channel patterns can be recalled from memory locations 1 to 100. As soon as the channel pattern is recalled, the front panel status channel display will immediately update to that channel pattern.

If you recall a channel pattern from a memory location that does not have a stored channel pattern, it is the same as recalling a blank channel pattern. A blank channel pattern has no closed channels. All channels for both slots will open.

Channel patterns can be stored in memory using the SAVe command (see previous command).

Programming example

The following example will demonstrate the use of the MEMory commands of the ROUTe subsystem:

```
10  OUTPUT 707; ":clos (@ 1!1:1!10)"
20  OUTPUT 707; ":mem:sav M36"
30  OUTPUT 707; ":open all"
40  WAIT 3
50  OUTPUT 707; ":mem:rec M36"
60  END
```

Line 10 Closes channels 1 through 10 of Slot 1.

Line 20 Saves the channel pattern to memory location M36.

Line 30 Opens all channels.

Line 40 Delays for three seconds.

Line 50 After three seconds, channel pattern at M36 is recalled closing channels 1 through 10.

5.10.4 :SENSe[1] subsystem

The SENSe[1] subsystem is used to read the single channel digital input port of the Model 7001. The sense subsystem is summarized in Table 5-11.

Table 5-11
SENSe command summary

Command	Description
:SENSe[1]	
:TTL1	Command path for input port.
:DATA?	Read digital input port.

:TTL1

:SENSe[1]:TTL1

This command path, along with the following command, is used to read the digital input port.

:DATA?

:SENSe[1]:TTL1:DATA?

Format

:sens:ttl1:data?

Description

This query command is used to read the digital input port. After sending this command and addressing the Model 7001 to talk, the state (0 or 1) of the input port will be sent to the computer.

Programming example

```
10 OUTPUT 707; ":sens:ttl1:data?"
20 ENTER 707; A$
30 PRINT A$
40 END
```

Line 10 Requests status of input port.
Line 20 Addresses 7001 to talk.
Line 30 Displays input port status on CRT.

NOTE

The Model 7001 also has commands for SENSe2 and SENSe3 subsystems, which are reserved for future use.

5.10.5 :SOURce subsystem

The SOURce subsystem is used to control the bits of the four channels of the digital output port. Table 5-12 summarizes the source subsystem.

Table 5-12
SOURce command summary

Command	Description
:SOURce	Command path to program digital output port bits:
:TTL1	Path to program Bit 1 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 1.
:TTL2	Path to program Bit 2 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 2.
:TTL3	Path to program Bit 3 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 3.
:TTL4	Path to program Bit 4 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 4.

Note: Command shortform is indicated by the upper case characters. For example, instead of sending "source:ttl1 on", you can send "sour:ttl1 on".

:TTL1

:SOURce:TTL1

This command path is used to program (and query) Bit 1 of the digital output port. The following commands are used in this path:

[:LEVel] <b>

:SOURce:TTL1[:LEVel] <b>

This command is implied (as indicated by the brackets; []) and need not be included in the command string to program Bit 1. Only the parameter needs to be included.

Parameters

b = 0 or OFF Clears Bit 1
b = 1 or ON Sets Bit 1

Format :sour:ttl1 b

Description

Power-up	Clears all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description This command is used set (1) or reset (0) Bit 1 of the digital output port. Notice in the above format, that :LEVel is not included in the command string since it is optional.

The level of Bit 1 depends on its programmed polarity. If the polarity of Bit 1 is active-high, "1 or ON" equals +5V, and "0 or OFF" equals 0V. Conversely, if the polarity is active-low, "1 or ON" equals 0V, and "0 or OFF" equals +5V. Polarity is programmed by the OUTPut subsystem.

[:LEVel]?

:SOURce:TTL1[:LEVel]?

The portion of the command in the brackets "[]" is implied and need not be included in the command string to query Bit 1. Only the question mark (?) needs to be included.

Format :sour:ttl1?

Description This query command is used to request the status of Bit 1 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

After this command is sent and the Model 7001 is addressed to talk, the status (0 or 1) of Bit 1 will be sent to the computer.

:TTL2

:SOURce:TTL2

This command path is used to program (and query) Bit 2 of the digital output port. The following commands are used in this path:

[:LEVel] <b>

:SOURce,:TTL2[:LEVel] <b>

This command is implied (as indicated by the brackets; []) and need not be included in the command string to program Bit 2. Only the parameter needs to be included.

Parameters

b = 0 or OFF	Clears Bit 2
b = 1 or ON	Sets Bit 2

Format

:sour:ttl2 b

Defaults

Power-up	Clears all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command is used set (1) or reset (0) Bit 2 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

The level of Bit 2 depends on its programmed polarity. If the polarity of Bit 2 is active-high, "1 or ON" equals +5V, and "0 or OFF" equals 0V. Conversely, if the polarity is active-low, "1 or ON" equals 0V, and "0 or OFF" equals +5V. Polarity is programmed by the OUTPut subsystem.

[:LEVel]?

:SOURce:TTL2[:LEVel]?

The portion of the command in the brackets "[]" is implied and need not be included in the command string to query Bit 2. Only the question mark (?) needs to be included.

Format

:sour:ttl2?

Description

This query command is used to request the status of Bit 2 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

After this command is sent and the Model 7001 is addressed to talk, the status (0 or 1) of Bit 2 will be sent to the computer.

:TTL3

:SOURce:TTL3

This command path is used to program (and query) Bit 3 of the digital output port. The following commands are used in this path:

[:LEVel] <b>

:SOURce:TTL3[:LEVel] <b>

This command is implied (as indicated by the brackets; []) and need not be included in the command string to program Bit 3. Only the parameter needs to be included.

Parameters

b = 0 or OFF	Clears Bit 3
b = 1 or ON	Sets Bit 3

Format

:sour:ttl3 b

Defaults

Power-up	Clears all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command is used set (1) or reset (0) Bit 3 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

The level of Bit 3 depends on its programmed polarity. If the polarity of Bit 3 is active-high, "1 or ON" equals +5V, and "0 or OFF" equals 0V. Conversely, if the polarity is active-low, "1 or ON" equals 0V, and "0 or OFF" equals +5V. Polarity is programmed by the OUTPut subsystem.

[:LEVel]?

:SOURce:TTL3[:LEVel]?

The portion of the command in the brackets "[]" is implied and need not be included in the command string to query Bit 3. Only the question mark (?) needs to be included.

Format

:sour:ttl3?

Description

This query command is used to request the status of Bit 3 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

After this command is sent and the Model 7001 is addressed to talk, the status (0 or 1) of Bit 3 will be sent to the computer.

:TTL4

:SOURce:TTL4

This command path is used to program (and query) Bit 4 of the digital output port. The following commands are used in this path:

[:LEVel] <b>

:SOURce:TTL4[:LEVel] <b>

This command is implied (as indicated by the brackets; []) and need not be included in the command string to program Bit 4. Only the parameter needs to be included.

Parameters

b = 0 or OFF	Clears Bit 4
b = 1 or ON	Sets Bit 4

Format

:sour:ttl4 b

Defaults

Power-up	Clears all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This command is used set (1) or reset (0) Bit 4 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

The level of Bit 4 depends on its programmed polarity. If the polarity of Bit 4 is active-high, "1 or ON" equals +5V, and "0 or OFF" equals 0V. Conversely, if the polarity is active-low, "1 or ON" equals 0V, and "0 or OFF" equals +5V. Polarity is programmed by the OUTPut subsystem.

[:LEVel]?

:SOURce:TTL4[:LEVel]?

The portion of the command in the brackets "[]" is implied and need not be included in the command string to query Bit 4. Only the question mark (?) needs to be included.

Format

:sour:ttl4?

Description

This query command is used to request the status of Bit 4 of the digital output port. Notice in the above format that :LEVel is not included in the command string since it is optional.

After this command is sent and the Model 7001 is addressed to talk, the status (0 or 1) of Bit 4 will be sent to the computer.

Programming example

This programming example will demonstrate the use of the SOURce subsystem commands:

```
10 OUTPUT 707; ":sour:ttl1 on;ttl2 off;ttl3 on;ttl4 off"
20 OUTPUT 707; ":sour:ttl1?;ttl2?;ttl3?;ttl4?"
30 ENTER 707; A$
40 PRINT A$
50 END
```

Line 10 Four commands on this line; TTL1 sets Bit 1, TTL2 resets Bit 2, TTL3 sets Bit 3 and TTL4 resets Bit 4.

Line 20 Four query commands on this line. TTL1? through TTL4? requests the state of the four output port bits.

Line 30 Addresses the 7001 to talk.

Line 40 Displays (on the CRT) the state of the output port bits in the order that the query commands were sent (0, 1, 0, 1).

5.10.6 :STATus subsystem

The STATus subsystem is used to control the status registers of the Model 7001. These registers and the overall status structure are explained in paragraph 5.6.

The commands in this subsystem are summarized in Table 5-13.

Table 5-13
STATus command summary

Command	Description
:STATus	
:OPERation	Path to control operation event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 to 1122).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 to 1122).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 to 1122).
:ENABle?	Read the enable register.
:ARM	Path to control arm event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 or 2).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 or 2).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 or 2).
:ENABle?	Read the enable register.
:SEQuence	Path to control the sequence event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 to 6).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 to 6).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 to 6).
:ENABle?	Read the enable register.

Command	Description
:TRIGger	Path to control trigger event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 or 2).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 or 2).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 or 2).
:ENABle?	Read the enable register.
:PRESet	Return status registers to default states.
:QUEue	Path to access error queue:
[:NEXT]?	Request most recent error message.
:ENABle <list>	Specify error and status messages for queue.
:QUEStionable	Path to control questionable event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register.
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register.
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register.
:ENABle?	Read the enable register.

*The Model 7001 does not implement the QUEStionable commands of the STATus subsystem. They are included here only because they are part of the SCPI structure.

Note: Command shortform is indicated in uppercase characters. For example, instead of sending "status:operation:condition?", you can instead send "stat:oper:cond?".

:OPERation

:STATus:OPERation

This command path is used to control the operation event registers. The Model 7001 uses the following commands in this path:

[:EVENt]?

:STATus:OPERation[:EVENt]?

The brackets "[]" that enclose :EVENT indicate (by SCPI definition) that the command is implied and need not be used. Thus, the command can be simplified by using only the question mark (?) as shown in the "Format".

Format :stat:oper?

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	Clears (0) all bits
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description This query command is used to read the Operation Event Status Register. After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the register are set. The Operation Event Status Register is shown in Figure 5-17. Note that this query command clears the Operation Event Status Register.

For example, for an acquired decimal value of 34, the binary equivalent is 00100010. For this binary value, bits B5 and B1 of the Operation Event Status Register are set.

The significance of a set bit in this register depends on how the transition filter is set up (see :PTRansition and :NTRansition commands). If an event is programmed for a positive transition (PTR), the corresponding bit in this register will set when the event begins to occur. For example, bit B10 in this register will set when a scan begins. If the event is instead programmed for a negative transition (NTR), the bit will not set until the completion of the event. For example, bit B10 will set at the conclusion of the scan.

The bits of the Operation Event Status Register are described as follows.

Bit 0 — Not Used.

Bit 1, Settling (Set) — Set bit indicates that the scan is currently in the settling period for a relay (PTR) or the settling period has expired (NTR).

Bits 2 through 4 — Not Used.

Bit 5, Waiting for Trigger (Trig) — Set bit indicates that the instrument is waiting for a trigger (PTR) or that the trigger has occurred (NTR).

Bit 6, Waiting for Arm (Arm) — Set bit indicates that the instrument is waiting for an arm (PTR) or that the arm has occurred (NTR).

Bit 7 through 9 — Not Used.

Bit 10, Idle — Set bit indicates that the instrument is in the Idle state (PTR), or the instrument has left the idle state to perform a scan (NTR).

Bits 11 through 15 — Not Used.

Bit Position	(B15 - B11)	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
Event	——	Idle	—	—	—	Arm	Trig	—	—	—	Set	—
Decimal Weighting	2^{15} - 2^{11}	1024 (2^{10})	— (2^{9})	— (2^{8})	— (2^{7})	64 (2^{6})	32 (2^{5})	— (2^{4})	— (2^{3})	— (2^{2})	2 (2^{1})	— (2^{0})
Value	——	0/1	—	—	—	0/1	0/1	—	—	—	0/1	—

Value : 1 = Operation Event Set
0 = Operation Event Cleared

Events : Idle = Idle state of the 7001
Arm = Waiting for Arm
Trig = Waiting for Trigger
Set = Settling

Figure 5-17
Operation Event Status Register

:CONDition?

:STATus:OPERation:CONDition?

Format

:stat:oper:cond?

Description

This query command is used to read the contents of the Operation Event Condition Register. The condition register is the same as the Operation Event Status Register except it is a real-time register that constantly updates to reflect the current status of the instrument.

After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 1024, the binary equivalent is 0000010000000000. For this binary value, bit B10 is set indicating that a scan is in process. Note that at the completion of the scan, bit B10 will reset.

:PTRansition <n>

:STATus:OPERation:PTRansition <n>

Parameters

n = 0 Clear PTR register
n = 2 Set settling bit (B1) of PTR register

n = 32 Set Trig bit (B5) of PTR register
n = 64 Set Arm bit (B6) PTR register
n = 1024 Set Idle bit (B10) of PTR register

Format

:stat:oper:ptr n

Defaults

Power-up	Sets (1) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Sets (1) all bits

Description

This command is used to program the positive transition register (PTR). A positive transition is defined as a 0 to 1 state change in the condition register. Thus, when an operation event is programmed for a positive transition, the appropriate bit in the Operation Event Status Register will set when the corresponding bit in the Operation Event Condition Register changes from 0 to 1. For example, if the idle event (bit B10) is programmed for a positive transition, the Idle bit (B10) in the Operation Event Status Register will set when the instrument leaves the scan mode (arm indicator turns off). Leaving the scan mode causes bit B10 in the condition register to change from 0 to 1 (positive transition). For details on register structure, see paragraph 5.6.

The PTR register is shown in Figure 5-18A and includes the decimal weight of each bit. The sum of the decimal weights of the bits that you wish to set is the parameter (n) that is sent with the command. For example, to program Idle (B10) and Trig (B5) events for positive transitions, send the following command:

stat:oper:ptr 1056

where; Idle (bit B10) = Decimal 1024
Trig (bit B5) = Decimal 32
n = 1056

The effects of positive transitions on the Operation Event Status Register are summarized as follows:

Operation Event	Positive Transition Effect On Operation Event Status Register
Settling	Sets B1 at the start of the settling period.
Waiting for Trigger	Sets B5 at the start of the Waiting for Trigger period.
Waiting for Arm	Sets B6 at the start of the Waiting for Arm period.
Idle	Sets B10 when the instrument is in the idel state.

The contents of the PTR register can be read using the :PTRansition? query command.

:PTRansition?

:STATus:OPERation:PTransition?

Format

:stat:oper:ptr?

Description

This query command is used to read the contents of the positive transition (PTR) register (see Figure 5-18A). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 1056, the binary equivalent is 0000010000100000. For this binary value, bits B10 and B5 are set.

The PTR register is programmed using the :PTRansition command.

:NTRansition <n>

:STATus:OPERation:NTRansition <n>

Parameters

n = 0	Reset NTR register
n = 2	Set settling bit (B1) of NTR register
n = 32	Set Trig bit (B5) of NTR register
n = 64	Set Arm bit (B6) NTR register
n = 1024	Set Idle bit (B10) of NTR register

Format

:stat:oper:ntr n

Power-Up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to program the negative transition register (NTR). A negative transition is defined as a 1 to 0 state change in the condition register. Thus, when an operation event is programmed for a negative transition, the appropriate bit in the Operation Event Status Register will set when the corresponding bit in the Operation Event Condition Register changes from 1 to 0. For example, if the idle event (bit B10) is programmed for a negative transition, the Idle bit (B10) in the Operation Event Status Register will set when the instrument leaves the idle state.

The NTR register is shown in Figure 5-18B and includes the decimal weight of each bit. The sum of the decimal weights of the bits that you wish to set is the parameter (n) that is sent with the command. For example, to program Idle (B10) and Trig (B5) events for negative transitions, send the following command:

stat:oper:ntr 1056

where; Idle (bit B10) = Decimal 1024
Trig (bit B5) = Decimal 32
n = 1056

The effects of negative transitions on the Operation Event Status Register are summarized as follows:

Operation Event	Negative Transition Effect On Operation Event Status Register
Settling	Sets B1 at the end of the settling period.
Waiting for Trigger	Sets B5 at the end of the Waiting for Trigger period.
Waiting for Arm	Sets B6 at the end of the Waiting for Arm period.
Idle	Sets B10 when instrument leaves the idle state.

The contents of the NTR register can be read using the :NTRansition? query command.

:NTRansition?

:STATus:OPERation:NTRansition?

Format

:stat:oper:ntr?

Description

This query command is used to read the contents of the negative transition (NTR) register (see Figure 5-18B). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 1056, the binary equivalent is 0000010000100000. For this binary value, bits B10 and B5 are set.

The NTR register is programmed using the :NTRansition command.

Bit Position	(B15 - B11)	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
Event	——	Idle	—	—	—	Arm	Trig	—	—	—	Set	—
Decimal Weighting	2^{15} - 2^{11}	1024 (2^{10})	— (2^{9})	— (2^{8})	— (2^{7})	64 (2^{6})	32 (2^{5})	— (2^{4})	— (2^{3})	— (2^{2})	2 (2^{1})	— (2^{0})
Value	——	0/1	—	—	—	0/1	0/1	—	—	—	0/1	—

Value : 1 = Enable Positive Transition
0 = Disable Positive Transition

A) Positive Transition (PTR) Register

Bit Position	(B15 - B11)	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
Event	——	Idle	—	—	—	Arm	Trig	—	—	—	Set	—
Decimal Weighting	2^{15} - 2^{11}	1024 (2^{10})	— (2^{9})	— (2^{8})	— (2^{7})	64 (2^{6})	32 (2^{5})	— (2^{4})	— (2^{3})	— (2^{2})	2 (2^{1})	— (2^{0})
Value	——	0/1	—	—	—	0/1	0/1	—	—	—	0/1	—

Value : 1 = Enable Negative Transition
0 = Disable Negative Transition

B) Negative Transition (NTR) Register

Figure 5-18
Operation Event Transition Filter

:ENABle <n>

:STATus:OPERation:ENABle <n>

Parameters

n = 0	Clear enable register
n = 2	Set bit B1 (Set) of Operation Event Status Enable Register
n = 32	Set bit B5 (Trig) of Operation Event Status Enable Register
n = 64	Set bit B6 (Arm) of Operation Event Status Enable Register
n = 1024	Set bit B10 (Idle) of Operation Event Status Enable Register

Format :stat:oper:enab n

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to set the contents of the Operation Event Status Enable Register (see Figure 5-19). This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of each bit in the register. Notice that only four bits (B1, B5, B6 and B10) of the register are used by the Model 7001.

This enable register is used as a mask for operation events. When a bit in this register is cleared (0), the corresponding bit in the Operation Event Status Register is masked and thus, cannot set the Operation Summary Bit (OSB) in the Status Byte Register. Conversely, when a bit in the enable register is set (1), the corresponding bit in the Operation Event Status Register is unmasked. When the unmasked bit in the Operation Event Status sets, the OSB bit in the Status Byte Register will set.

The decimal weighting of the bits is included in Figure 5-19. The sum of the decimal weights of the bits that you wish to set is sent as the parameter (n) for the :ENABle command. For example, to set the Arm and Trig bits of the Operation Event Status Enable Register, send the following command:

:stat:oper:enab 96

where;	Arm (bit B6) = Decimal	64
	Trig (bit B5) = Decimal	32
		n = 96

For descriptions of the operation event bits, see the [:EVENt]? command. The Operation Event Status Enable Register can be read using the next command (:ENABle?).

:ENABle?

:STATus:OPERation:ENABle?

Format

:stat:oper:enab?

Description

This query command is used to read the contents of the Operation Event Status Enable Register (see Figure 5-19). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 96, the binary equivalent is 01100000. For this binary value, bits B5 and B6 of the Operation Event Status Enable Register are set.

The :ENABle command (see previous command) is used to program the Operation Event Status Enable Register.

Programming example

The following programming example will demonstrate how to use the commands of the STATus subsystem to program the operation event registers:

```
10 OUTPUT 707; ":stat:oper:ptr 1120;ntr 0;enab 1120"
20 OUTPUT 707; ":stat:oper:ptr?;ntr?;enab?"
30 ENTER 707; A$
40 PRINT A$
50 END
```

Line 10 Three commands on this line; PTRansition and NTRansition programs all events for positive transitions, and ENABle enables all events.

Line 20 Three query commands on this line; PTRansition? and NTRansition? reads the transition filter registers, and ENABle? reads the enable register.

Line 30 Addresses the 7001 to talk.

Line 40 Displays the status of the registers in the order that they were requested (1120, 0, 1120).

Bit Position	(B15 - B11)	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
Event	——	Idle	—	—	—	Arm	Trig	—	—	—	Set	—
Decimal Weighting	2^{15} - 2^{11}	1024 (2^{10})	— (2^{9})	— (2^{8})	— (2^{7})	64 (2^{6})	32 (2^{5})	— (2^{4})	— (2^{3})	— (2^{2})	2 (2^{1})	— (2^{0})
Value	——	0/1	—	—	—	0/1	0/1	—	—	—	0/1	—

Value : 1 = Enable Operation Event
0 = Disable (Mask) Operation Event

Events : Idle = Idle state of 7001
Arm = Waiting for Arm
Trig = Waiting for Trigger
Set = Settling

Figure 5-19
Operation Event Status Enable Register

:ARM

:STATus:OPERation:ARM

The following commands in this path are used to control the arm event registers:

[:EVENt]?

:STATus:OPERation:ARM[EVENt]?

The brackets "[]" that enclose :EVENt indicate (by SCPI definition) that the command is implied and need not be used. Thus, the command can be simplified by using only the question mark (?) as shown in the "Format".

Format

:stat:oper:arm?

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	Clears (0) all bits
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This query command is used to read the Arm Event Status Register. After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the register are set. The Arm Event Status Register is shown in Figure 5-20. Notice that only the Seq1 bit (B1) of the register is used. Note that this query command clears the Arm Event Status Register.

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	——	Seq1	—
Decimal Weighting	(2^{15})	$(2^{14} - 2^{2})$	2 (2^{1})	(2^{0})
Value	—	——	0/1	—

Value : 1 = Event Bit Set
0 = Event Bit Cleared

Event : Seq 1 = Sequence 1

Figure 5-20
Arm Event Status Register

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 of the Arm Event Status Register is set.

The significance of bit B1 being set depends on how the transition filter is set up (see :PTRansition and :NTRansition commands). If the arm event is programmed for a pos-

itive transition (PTR), bit B1 in this register will set when the instrument first enters an arm layer. If the arm event is instead programmed for a negative transition (NTR), the bit will not set until the completion of the event.

The only bit of the Arm Event Status Register that is used is the Seq1 bit (B1) and is described as follows:

Bit B1, Sequence 1 (Seq1) — Set bit indicates that the instrument is in an arm layer of Sequence 1 (PTR), or that the instrument has exited from an arm layer of Sequence 1 (NTR).

:CONDition?

:STATus:OPERation:ARM:CONDition?

Format

:stat:oper:arm:cond?

Description

This query command is used to read the contents of the Arm Event Condition Register. This is the same as the Arm Event Status Event Register except that it is a real-time register that constantly updates to reflect the current status of the instrument.

After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set. Remember that bit B1 (Seq1) is the only one used by the Model 7001.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set indicating that the instrument is in an arm layer of Sequence 1. Note that when the instrument exits from the arm layer, bit B1 will reset.

:PTRansition <n>

:STATus:OPERation:ARM:PTRansition <n>

Parameters

n = 0 Reset PTR register
n = 2 Set bit B1 (Seq1) of the PTR register

Format

:stat:oper:arm:ptr n

Defaults

Power-up	Sets (1) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Sets (1) all bits

Description

This command is used to program the positive transition (PTR) register (see Figure 5-21A). A positive transition is defined as a 0 to 1 state change in the condition register.

Thus, when the arm event is programmed for a positive transition, bit B1 in the Arm Event Status Register will set when bit B1 in the Arm Event Condition Register changes from 0 to 1. The 0 to 1 transition occurs when the instrument enters an arm layer of Sequence 1.

The PTR register shown in Figure 5-21A includes the decimal weight of each bit. Since only one bit of the register is used, the parameter (n) to set bit B1 is decimal 2. The following command will program Seq1 (B1) for a positive transition:

:stat:oper:arm:ptr 2

The contents of the PTR register can be read using the :PTRansition? query command.

:PTRansition?

:STATus:OPERation:ARM:PTRansition?

Format

:stat:oper:arm:ptr?

Description

This query command is used to read the contents of the positive transition (PTR) register (see Figure 5-21A). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set.

The PTR register is programmed using the :PTRansition command.

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	———	Seq1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{2})	2 (2^{1})	(2^{0})
Value	—	———	0/1	—

Value : 1 = Enable Positive Transition
0 = Disable Positive Transition

A) Positive Transition (PTR) Register

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	———	Seq1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{2})	2 (2^{1})	(2^{0})
Value	—	———	0/1	—

Value : 1 = Enable Negative Transition
0 = Disable Negative Transition

B) Negative Transition (NTR) Register

Figure 5-21
Arm Event Transition Filter

:NTRansition<n>

:STATus:OPERation:ARM:NTRansition <n>

Parameters

n = 0 Reset NTR register
n = 2 Set bit B1 (Seq1) of the NTR register

Format

:stat:oper:arm:ntr n

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to program the negative transition (NTR) register (see Figure 5-21B). A negative transition is defined as a 1 to 0 state change in the condition register. Thus, when the arm event is programmed for a negative transition, bit B1 in the Arm Event Status Register will set when bit B1 in the Arm Event Condition Register changes from 1 to 0. The 1 to 0 transition occurs when the instrument exits from an arm layer of Sequence 1.

The NTR register shown in Figure 5-21B includes the decimal weight of each bit. Since only one bit of the register is used, the parameter (n) to set bit B1 is decimal 2. The following command will program Seq1 (B1) for a negative transition:

:stat:oper:arm:ntr 2

The contents of the NTR register can be read using the :NTRansition? query command.

:NTRansition?

:STATus:OPERation:ARM:NTRansition?

Format

:stat:oper:arm:ntr?

Description

This query command is used to read the contents of the negative transition (NTR) register (see Figure 5-21B). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set.

The NTR register is programmed using the :NTRansition command

:ENABle <n>

:STATus:OPERation:ARM:ENABle <n>

Parameters

n = 0 Clear enable register
n = 2 Set bit B1 (Seq1) of the Arm Event Status Enable Register

Format

:stat:oper:arm:enab n

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to set the contents of the Arm Event Status Enable Register (see Figure 5-22). This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of bit B1 in the register. Bit B1 is the only bit of the register used by the Model 7001.

This enable register is used as a mask for the arm event. When bit B1 is cleared (0), bit B1 in the Arm Event Status Register is masked and thus, cannot set bit B6 (Waiting for Arm) of the Operation Event Condition Register. Conversely, when bit B1 in the enable register is set (1), bit B1 in the Arm Event Status Register is unmasked. When the unmasked bit in the Arm Event Status sets, bit B6 in the Operation Event Condition Register will set.

The decimal weighting of the bits is included in Figure 5-22. Since only one bit of the register is used, the parameter (n) to set bit B1 is decimal 2. The following command will unmask (enable) the arm event (Seq1):

:stat:oper:arm:enab 2

The Arm Event Status Enable Register can be read using the next command (:ENABle?).

:ENABle?

:STATus:OPERation:ARM:ENABle?

Format

:stat:oper:arm:enab?

Description

This query command is used to read the contents of the Arm Event Status Enable Register (see Figure 5-22). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent 0000000000000010. For this binary value, bit B1 of the Arm Event Status Enable Register is set.

The :ENABle command (see previous command) is used to program the Arm Event Status Enable Register.

Programming example

The following programming example will demonstrate how to use the commands of the STATus subsystem to program the arm event registers:

```
10 OUTPUT 707; ":stat:oper:arm:ptr 2;ntr 0;enab 2"
20 OUTPUT 707; ":stat:oper:arm:ptr?;ntr?;enab?"
```

```
30 ENTER 707; A$
40 PRINT A$
50 END
```

Line 10 Three commands on this line; :PTRansition and :NTRansition programs all events for positive transitions, and ENABle enables all events.

Line 20 Three query commands on this line; :PTRansition? and :NTRansition? reads the transition filter registers, and ENABle? reads the enable register.

Line 30 Addresses the 7001 to talk.

Line 40 Displays the status of the registers in the order that they were requested (2, 0, 2).

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	——	Seq1	—
Decimal Weighting	(2^{15})	$(2^{14} - 2^{2})$	2 (2^{1})	(2^{0})
Value	—	——	0/1	—

Value : 1 = Enable Arm Event
0 = Disable (Mask) Arm Event

Event : Seq 1 = Sequence 1

Figure 5-22
Arm Event Status Enable Register

:SEQuence

:STATus:OPERation:ARM:SEQuence

The following commands in this path are used to control the sequence event registers:

[:EVENt]?

:STATus:OPERation:ARM:SEQuence]:EVENt]?

The brackets "[]" that enclose :EVENt indicate (by SCPI definition) that the command is implied and need not be used. Thus, the command can be simplified by using only the question mark (?) as shown in the "Format".

Format

:stat:oper:arm:seq?

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	Clears (0) all bits
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This query command is used to read the Sequence Event Status Register. After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the register are set. The Sequence Event Status Register is shown in Figure 5-23. Notice that only two bits (B1 and B2) of the register are used. This query command clears the Sequence Event Status Register.

For example, for an acquired decimal value of 4, the binary equivalent is 0000000000000100. For this binary value, bit B2 of the Sequence Event Status Register is set.

The significance of bit B2 being set depends on how the transition filter is set up (see :ptransition and :ntransition commands). If the sequence event is programmed for a positive transition (PTR), bit B2 in this register will set when the instrument first enters the Arm1 layer. If the sequence event is instead programmed for a negative transition (NTR), the bit will not set until the completion of the event.

The only bits of the Sequence Event Status Register that are used are Lay1 (B1) and Lay2 (B2) and are described as follows:

Bit B1, Layer 1 (Lay1) — Set bit indicates that the instrument is in the Arm1 layer (PTR), or that the instrument has exited from the layer (NTR).

Bit B2, Layer 2 (Lay2) — Set bit indicates that the instrument is in the Arm2 layer (PTR), or that the instrument has exited from the layer (NTR).

Bit Position	B15	(B14 - B3)	B2	B1	B0
Event	—	——	Lay2	Lay1	—
Decimal Weighting	(2^{15})	$(2^{14} - 2^{3})$	4 (2^{2})	2 (2^{1})	(2^{0})
Value	—	——	0/1	0/1	—

Value : 1 = Event Bit Set
0 = Event Bit Cleared

Event : Lay1 = Layer 1
Lay2 = Layer 2

Figure 5-23
Sequence Event Status Register

:CONDition?

:STATus:OPERation:ARM:SEQuence:CONDition?

Format

:stat:oper:arm:seq:cond?

Description

This query command is used to read the contents of the Sequence Event Condition Register. This register is similar to the Sequence Event Status Register except that it is a real-time register that constantly updates to reflect the current status of the instrument.

After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set indicating that the instrument is in the Arm1 layer. Note that when the instrument exits from the layer, bit B1 will reset.

:PTRansition <n>

:STATus:OPERation:ARM:SEQuence:PTRansition <n>

Parameters

n = 0 Reset PTR register
n = 2 Set bit B1 (Lay1) of the PTR register
n = 4 Set bit B2 (Lay2) of the PTR register

Format

:stat:oper:arm:seq:ptr n

Defaults

Power-up	Sets (1) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Sets (1) all bits

Description

This command is used to program the positive transition (PTR) register (see Figure 5-24A). A positive transition is defined as a 0 to 1 state change in the condition register. Thus, when a sequence event is programmed for a positive transition, the appropriate bit in the Sequence Event Status Register will set when the corresponding bit in the Sequence Event Condition Register changes from 0 to 1. The 0 to 1 transition occurs when the instrument enters the Arm1 layer.

The PTR register shown in Figure 5-24A includes the decimal weight of each bit. The sum of the decimal weights of the bits that you wish to set is the parameter (n) that is sent with the command. For example, to program both Lay1 (B1) and Lay2 (B2) for positive transitions, send the following command:

:stat:oper:arm:seq:ptr 6

where; Lay1 (bit B1) = Decimal 2
Lay2 (bit B2) = Decimal 4
n = 6

The contents of the PTR register can be read using the :PTRansition? query command.

:PTRansition?

:STATus:OPERation:ARM:SEQuence:PTRansition?

Format

:stat:oper:arm:seq:ptr?

Description

This query command is used to read the contents of the positive transition (PTR) register (see Figure 5-24B). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 6, the binary equivalent is 0000000000000110. For this binary value, bits B1 and B2 are set.

The PTR register is programmed using the :PTRansition command.

:NTRansition <n>

:STATus:OPERation:ARM:SEQuence:NTRansition <n>

Parameters

n = 0 Reset NTR register
n = 2 Set bit B1 (Lay1) of the NTR register
n = 4 Set bit B2 (Lay2) of the NTR register

Format

:stat:oper:arm:seq:ntr n

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to program the negative transition (NTR) register. A negative transition is defined as a 1 to 0 state change in the condition register. Thus, when a sequence event is programmed for a negative transition, the appropriate bit in the Sequence Event Status Register will set when the corresponding bit in the Sequence Event Condition Register changes from 1 to 0. The 1 to 0 transition occurs when the instrument exits from the Arm1 layer.

The NTR register shown in Figure 5-24B includes the decimal weight of each bit. The sum of the decimal weights of the bits that you wish to set is the parameter (n) that is sent with the command. For example, to program both Lay1 (B1) and Lay2 (B2) for negative transitions, send the following command:

:stat:oper:arm:seq:ntr 6

where; Lay1 (bit B1) = Decimal 2
Lay2 (bit B2) = Decimal 4
n = 6

The contents of the NTR register can be read using the :NTRansition? query command.

:NTRansition?

:STATus:OPERation:ARM:SEQuence:NTRansition?

Format

:stat:oper:arm:seq:ntr?

Description

This query command is used to read the contents of the negative transition (NTR) register (see Figure 5-24B). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set.

The NTR register is programmed using the :NTRansition command.

Bit Position	B15	(B14 - B3)	B2	B1	B0
Event	—	———	Lay2	Lay1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{3})	4 (2^{2})	2 (2^{1})	(2^{0})
Value	—	———	0/1	0/1	—

Value : 1 = Enable Positive Transition
0 = Disable Positive Transition

A) Positive Transition (PTR) Register

Bit Position	B15	(B14 - B3)	B2	B1	B0
Event	—	———	Lay2	Lay1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{3})	4 (2^{2})	2 (2^{1})	(2^{0})
Value	—	———	0/1	0/1	—

Value : 1 = Enable Negative Transition
0 = Disable Negative Transition

B) Negative Transition (NTR) Register

Figure 5-24
Sequence Event Transistor Filter

:ENABle <n>

:STATus:OPERation:ARM:SEQuence:ENABle <n>

Parameters

n = 0 Clear enable register
n = 2 Set bit B1 (Lay1) of the Sequence Event Status Enable Register
n = 4 Set bit B2 (Lay2) of the Sequence Event Status Enable Register

Format

:stat:oper:arm:seq:enab n

Defaults

Power-Up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to set the contents of the Sequence Event Status Enable Register (see Figure 5-25). This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of bits B1 and B2 in the register.

This enable register is used as a mask for the sequence events. When a bit (B1 or B2) in this register is cleared (0), the corresponding bit in the Sequence Event Status Register is masked (disabled) and thus, cannot set the Seq1 bit (In an arm layer of Sequence 1) of the Arm Event Condition Register. Conversely, when bit B1 or B2 in the Sequence Event Status Enable Register is set (1), the corresponding bit in the Sequence Event Status Register is unmasked (enabled). When the unmasked bit sets, the Seq1 bit (B1) in the Arm Event Condition Register will set.

The Sequence Event Status Enable Register shown in Figure 5-25 includes the decimal weighting of the bits. The sum of the decimal weights of the bits that you wish to unmask is sent as the parameter (n) with :ENABLe command. For example, if you wish to unmask both sequence event bits (B1 and B2), send the following command:

:stat:oper:arm:seq:enab 6

where: Lay1 (bit B1) = Decimal 2
Lay2 (bit B2) = Decimal 4
n = 6

The Sequence Event Status Enable Register can be read using the next command (:ENABle?).

:ENABle?

:STATus:OPERation:ARM:SEQuence:ENABle?

Format

:stat:oper:arm:seq:enab?

Description

This query command is used to read the contents of the Sequence Event Status Enable Register (see Figure 5-25). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 6, the binary equivalent is 0000000000000110. For this binary value, bits B1 and B2 of the Sequence Event Status Enable Register are set.

The :ENABle command (see previous command) is used to program the Sequence Event Status Enable Register.

Programming example

The following programming example will demonstrate how to use the commands of the STATus subsystem to program the sequence event registers:

```
10  OUTPUT 707; ":stat:oper:arm:seq:ptr 6;ntr 0;enab 6"
20  OUTPUT 707; ":stat:oper:arm:seq:ptr?;ntr?;enab?"
30  ENTER 707; A$
40  PRINT A$
50  END
```

Line 10 Three commands on this line; PTR and NTR programs all events for positive transitions, and ENABle enables all events.

Line 20 Three query commands on this line; PTR? and NTR? reads the transition filter registers, and ENABle? reads the enable register.

Line 30 Addresses the 7001 to talk.

Line 40 Displays the status of the registers in the order that they were requested (6, 0, 6).

Bit Position	B15	(B14 - B3)	B2	B1	B0
Event	—	——	Lay2	Lay1	—
Decimal Weighting	(2^{15})	$(2^{14} - 2^{3})$	4 (2^{2})	2 (2^{1})	(2^{0})
Value	—	——	0/1	0/1	—

Value : 1 = Enable Sequence Event
0 = Disable (Mask) Sequence Event

Events : Lay1 = Layer 1
Lay2 = Layer 2

Figure 5-25
Sequence Event Status Enable Register

:TRIGger

:STATus:OPERation:ARM:TRIGger

The following commands in this path are used to control the trigger event registers:

[:EVENt]?

:STATus:OPERation:ARM:TRIGger[:EVENt]?

The brackets "[]" that enclose :EVENt indicate (by SCPI definition) that the command is implied and need not be used. Thus, the command can be simplified by using only the question mark (?) as shown in the "Format".

Format

:stat:oper:trig?

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	Clears (0) all bits
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

This query command is used to read the Trigger Event Status Register. After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the register are set. The Trigger Event Status Register is shown in Figure 5-26. Notice that only the Seq1 bit (B1) of the register is used. This query command clears the Trigger Event Status Register.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 of the Trigger Event Status Register is set.

The significance of bit B1 being set depends on how the transition filter is set up (see :PTRansition and :NTRansition commands). If the trigger event is programmed for a positive transition (PTR), bit B1 in this register will set when the instrument first enters the trigger layer of Sequence 1. If the trigger event is instead programmed for a negative transition (NTR), the bit will not set until the completion of the event.

The only bit of the Trigger Event Status Register that is used is the Seq1 bit (B1) and is described as follows:

Bit B1, Sequence 1 (Seq1) — Set bit indicates that the instrument is in the trigger layer of Sequence 1 (PTR), or that the instrument has exited from the trigger layer of Sequence 1 (NTR).

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	——	Seq1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{2})	2 (2^{1})	(2^{0})
Value	—	——	0/1	—

Value : 1 = Event Bit Set
0 = Event Bit Cleared

Events : Seq 1 = Sequence 1

Figure 5-26
Trigger Event Status Register

:CONDition?

:STATus:OPERation:ARM:TRIGger:CONDition?

Format

:stat:oper:trig:cond?

Description

This query command is used to read the contents of the Trigger Event Condition Register. This register is similar to the Trigger Event Status Register except that it is a real-time register that constantly updates to reflect the current status of the instrument.

After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set. Remember that bit B1 (Seq1) is the only one used by the Model 7001.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set indicating that the instrument is in the trigger layer of Sequence 1. Note that when the instrument exits from the trigger layer, bit B1 will reset.

:PTRansition <n>

:STATus:OPERation:ARM:TRIGger:PTRansition <n>

Parameters

n = 0 Reset PTR register
n = 2 Set bit B1 (Seq1) of the PTR register

Format :stat:oper:trig:ptr n

Defaults

Power-up	Sets (1) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Sets (1) all bits
:STATus:PRESet	Sets (1) all bits

Description This command is used to program the positive transition (PTR) register (see Figure Figure 5-27A). A positive transition is defined as a 0 to 1 state change in the condition register. Thus, when the trigger event is programmed for a positive transition, bit B1 in the Trigger Event Status Register will set when bit B1 in the Trigger Event Condition Register changes from 0 to 1. The 0 to 1 transition occurs when the instrument enters the trigger layer of Sequence 1.

The PTR register shown in Figure 5-27A includes the decimal weight of each bit. Since only one bit of the register is used, the parameter (n) to set bit B1 is decimal 2. The following command will program Seq1 (B1) for a positive transition:

:stat:oper:trig:ptr 2

The contents of the PTR register can be read using the :PTRansition? query command.

:PTRansition?

:STATus:OPERation:ARM:TRIGger:PTRansition?

Format :stat:oper:trig:ptr?

Description This query command is used to read the contents of the positive transition (PTR) register (see Figure 5-27A). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set.

The PTR register is programmed using the :PTRansition command.

:NTRansition <n>

:STATus:OPERation:ARM:TRIGger:NTRansition <n>

Parameters

n = 0 Reset NTR register
n = 2 Set bit B1 (Seq1) of the NTR register

Format :stat:oper:trig:ntr n

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to program the negative transition (NTR) register (see Figure Figure 5-27B). A negative transition is defined as a 1 to 0 state change in the condition register. Thus, when the trigger event is programmed for a negative transition, bit B1 in the Trigger Event Status Register will set when bit B1 in the Trigger Event Condition Register changes from 1 to 0. The 1 to 0 transition occurs when the instrument exits from the trigger layer of Sequence 1.

The NTR register shown in Figure 5-27B includes the decimal weight of each bit. Since only one bit of the register is used, the parameter (n) to set bit B1 is decimal 2. The following command will program Seq1 (B1) for a negative transition:

:stat:oper:trig:ntr 2

The contents of the NTR register can be read using the :NTRansition? query command.

:NTRansition?

:STATus:OPERation:ARM:TRIGger:NTRansition?

Format

:stat:oper:trig:ntr?

Description

This query command is used to read the contents of the negative transition (NTR) register (see Figure 5-27B). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 is set.

The NTR register is programmed using the :NTRansition command.

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	——	Seq1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{2})	2 (2^{1})	(2^{0})
Value	—	——	0/1	—

Value : 1 = Enable Positive Transition
0 = Disable Positive Transition

A) Positive Transition (PTR) Register

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	——	Seq1	—
Decimal Weighting	(2^{15})	(2^{14} - 2^{2})	2 (2^{1})	(2^{0})
Value	—	——	0/1	—

Value : 1 = Enable Negative Transition
0 = Disable Negative Transition

B) Negative Transition (NTR) Register

Figure 5-27
Trigger Event Transition Filter

:ENABle <n>

:STATus:OPERation:ARM:TRIGger:ENABle <n>

Parameters

n = 0 Clear enable register
n = 2 Set bit B1 (Seq1) of Trigger Event Status Enable Register

Format

:stat:trig:enable n

Defaults

Power-up	Clears (0) all bits
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	Clears (0) all bits

Description

This command is used to set the contents of the Trigger Event Status Enable Register (see Figure 5-28). This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of bit B1 in the register.

This enable register is used as a mask for the trigger event. When bit B1 is cleared (0), bit B1 in the Trigger Event Status Register is masked and thus, cannot set bit B5 (Waiting for Trigger) of the Operation Event Condition Register. Conversely, when bit B1 in the enable register is set (1), bit B1 in the Trigger Event Status Register is unmasked. When the unmasked bit in the Trigger Event Status sets, bit B5 in the Operation Event Condition Register will set.

The Trigger Event Status Enable Register shown in Figure 5-28 includes the decimal weighting of the bits. Since only one bit of the register is used, the parameter (n) to set bit B1 is decimal 2. The following command will unmask (enable) the trigger event (Seq1):

:stat:oper:trig:enab 2

The Trigger Event Status Enable Register can be read using the next command (:ENABle?).

:ENABle?

:STATus:OPERation:ARM:TRIGger:ENABle?

Format

:stat:oper:trig:enab?

Description

This query command is used to read the contents of the Trigger Event Status Enable Register (see Figure 5-28). After sending this command and addressing the Model 7001 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, for an acquired decimal value of 2, the binary equivalent is 0000000000000010. For this binary value, bit B1 of the Trigger Event Status Enable Register is set.

The :ENABle command (see previous command) is used to program the Trigger Event Status Enable Register.

Programming example

The following programming example will demonstrate how to use the commands of the STATus subsystem to program the trigger event registers:

```
10  OUTPUT 707; ":stat:oper:trig:ptr 2;ntr 0;enab 2"
20  OUTPUT 707; ":stat:oper:trig:ptr?;ntr?;enab?"
```

```
30 ENTER 707; A$
40 PRINT A$
50 END
```

Line 10 Three commands on this line; PTR and NTR programs all events for positive transitions, and ENABle enables all events.

Line 20 Three query commands on this line; PTR? and NTR? reads the transition filter registers, and ENABle? reads the enable register.

Line 30 Addresses the 7001 to talk.

Line 40 Displays the status of the registers in the order that they were requested (2, 0, 2).

Bit Position	B15	(B14 - B2)	B1	B0
Event	—	———	Seq1	—
Decimal Weighting	(2^{15})	$(2^{14} - 2^{2})$	2 (2^{1})	(2^{0})
Value	—	———	0/1	—

Value : 1 = Enable Trigger Event
0 = Disable (Mask) Trigger Event

Events : Seq 1 = Sequence 1

Figure 5-28
Trigger Event Status Enable register

:PREset

:STATus:PREset

Format :stat:pres

Description When this command is sent, the SCPI event registers are affected as follows:

1. All bits of the positive transition filter registers are set to one (1).
2. All bits of the negative transition filter registers are reset to zero (0).
3. All bits of the following registers are reset to zero (0):
   A. Operation Event Status Enable Register.
   B. Questionable Event Status Enable Register.

4. All bits of the following registers are set to one (1):
   A. Trigger Event Status Event Register.
   B. Arm Event Status Event Register.
   C. Sequence Event Status Event Register.

Note: Registers not included in the above list are unaffected by this command.

Programming example

The following programming example demonstrates how to use the :PRESet command of the STATus subsystem:

```
OUTPUT 707; :stat:pres
```

:QUEue

:STATus:QUEue

This command path is used to read error and status messages from the Error/Status Queue. The following commands are used in this path:

[:NEXT]?

:STATus:QUEue[:NEXT]?

The brackets "[]" enclosing this command indicate that it is implied and need not be sent as shown in the Format.

Format

```
:stat:que?
```

Defaults

Power-Up	Clears Error/Status Queue
*RST	No effect
*CLS	Clears Error/Status Queue
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

As error and status messages occur, they are placed into the Error/Status Queue. This query command is used to read those messages.

The Error/Status Queue is a first-in, first-out (FIFO) register. Every time you read the queue, the "oldest" message is read and that message is then removed from the queue. The queue will hold up to 10 messages. If the queue becomes full, the message "350, 'Queue Overflow'" will occupy the last memory location in the register. On power-up, the Error/Status is empty. When the Error Queue is empty, the message "0, 'No error'" is placed in the Error Queue.

The messages in the queue are preceded by a number. Negative (-) numbers are used for SCPI defined messages, and positive (+) numbers are used for Keithley defined messages. The messages are listed in Table 5-3.

After this command is sent and the Model 7001 is addressed to talk, the "oldest" message in the queue is sent to the computer.

Note: The :STATus:QUEue? query command performs the same function as the :SYSTem:ERRor? query command (see SYSTem subsystem).

Programming example

The following program will read the "oldest" message in the Error/Status Queue:

```
5   DIM A$ [30]
10  OUTPUT 707; ":stat:que?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 5 Increase string size to accommodate the length of the messages.
Line 10 Requests the "oldest" message in the queue.
Line 20 Addresses the Model 7001 to talk.
Line 30 Displays the message on the CRT.

:ENABle <list>

:STATus:QUEue:ENABle <list>

Parameter

list = (numlist)

where; numlist is a specified list of messages that you wish to enable for the Error/Status Queue.

Format

:stat:que:enab (numlist)

Defaults

Power-up	Clears list
*RST	No effect
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

On power-up, all error and status messages are enabled and will go into the Error/Status queue as they occur. This command is used to specify which messages you want to go into the queue. When using this command, any message not specified will be disabled and prevented from entering the queue. Messages are specified by numbers (see Table 5-3). The following examples demonstrate various forms for expressing a message numlist:

Numlist	= -110	Single message.
	= -110, -140, -222	Messages separated by commas.
	= -110:-222	Range of messages (-100 through -222).
	= -110:-222, -230	Range entry and single entry separated by a comma.

Note: To disable all messages from entering the Error/Status Queue, send the following command:

:stat:que:enab ()

:QUEStionable

:STATus:QUEStionable

The :QUEStionable command is used as a path to control the questionable event registers. Since Model 7001 operation does not implement any of these registers, their use will not be documented. Keep in mind that these registers do exist (as required by the SCPI standard) and can be accessed just like any of other registers in the STATus subsystem.

5.10.7 SYSTem subsystem

The system subsystem contains miscellaneous commands that are summarized in Table 5-14.

Table 5-14
SYSTem command summary

Command	Description
:SYSTem	
:ERRor?	Request message from Error/Status Queue.
:POSetup RST | PRESet | SAV0 | SAV1 | SAV2 | SAV3 | SAV4 | SAV5 | SAV6 | SAV7 | SAV8 | SAV9	Select Power-on setup.
:PRESet	Return instrument to default conditions (see Table 5-6).
:VERSion?	Request the revision level of the SCPI Standard.

Note: Command shortform is indicated by the uppercase characters. For example, instead of sending "system:error?", you can instead send "syst:err?".

:ERRor?

:SYStem:ERRor?

Format

:syst:err?

Defaults

Power-up	Clears Error/Status Queue
*RST	No effect
*CLS	Clears Error/Status Queue
DCL, SDC	No effect
:SYSTem:PRESet	No effect
:STATus:PRESet	No effect

Description

As error and status messages occur, they are placed into the Error/Status Queue. This query command is used to read those messages.

The Error/Status Queue is a first-in, first-out (FIFO) register. Every time you read the queue, the "oldest" message is read and that message is then removed from the queue. The queue will hold up to 10 messages. If the queue becomes full, the message "350, 'Queue Overflow'" will occupy the last memory location in the register. On power-up, the Error/Status is empty. When the Error Queue is empty, the message "0, 'No error'" is placed in the Error Queue.

The messages in the queue are preceded by a number. Negative (-) numbers are used for SCPI defined messages, and positive (+) numbers are used for Keithley defined messages. Table 5-3 lists the messages.

After this command is sent and the Model 7001 is addressed to talk, the "oldest" message in the queue is sent to the computer.

Note: The :SYSTem:ERRor? query command performs the same function as the :STATus:QUEue? query command (see STATus subsystem).

Programming example

The following program will read the "oldest" message in the Error/Status Queue:

```
5   DIM A$ [30]
10  OUTPUT 707; ":syst:err?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 5 Increase string size to accommodate the length of the messages.
Line 10 Requests the "oldest" message in the queue.
Line 20 Addresses the Model 7001 to talk.
Line 30 Displays the message on the CRT.

:POSetup RST | PRESet | SAV0 | SAV1 | SAV2 | SAV3 | SAV4 | SAV5 | SAV6 | SAV7 | SAV8 | SAV9

:SYSTem:POSetup RST|PRESet|SAV0|SAV1|SAV2|SAV3|SAV4|SAV5|SAV6|SAV7|SAV8|SAV9

Parameters

RST	*RST default conditions
PRES	:SYSTem:PRESet default conditions
SAV0-SAV9	User defined default conditions

Formats

```
:syst:pos rst
:syst:pos pres
:syst:pos savX
where; X = 1 to 9
```

Description

This command is used to program the power-on defaults for the Model 7001. With RST selected, the instrument will power-up to the *RST default conditions. With PRES selected, the instrument will power-up to the :SYStem:PRESet default conditions. Table 5-6 defined the default conditions for these commands.

With SAV0 to SAV9 selected, the instrument will power-on to the setup that is saved in the specified memory location using the *SAV command.

Programming example

The following statement will program the instrument to power-on to the *RST default conditions:

```
OUTPUT 707; ":syst:pos rst"
```

:PRESet

:SYSTem:PRESet

Format

:syst:pres

Description

This command sets the instrument to a state optimized for front panel operation. (This is the same state as selected by the :syste:pos:pres command.) Table 5-6 defined the default values for this command.

Programming example

The following statement will program the instrument to the :syste:pres conditions:

```
OUTPUT 707; ":syste:pres"
```

:VERSion?

:SYSTem:VERSion?

Format

:syst:vers?

Description

This query command is used to request the version of the SCPI standard. After sending this command and addressing the Model 7001 to talk, the version message will be sent to the computer.

Programming example

The following program will request the software version:

```
10  OUTPUT 707; ":syst:vers?"
20  ENTER 707; A$
30  PRINT A$
40  END
```

Line 10 Requests the version level.
Line 20 Addresses the Model 7001 to talk.
Line 30 Displays the version message.

5.10.8 Trigger subsystem

The trigger subsystem is made up of a series of commands and subsystems to configure the three layers of scan operation. These commands and subsystems are summarized in Table 5-15.

Table 5-15
Trigger command summary

Command	Description
:INITiate	Subsystem command path:
[:IMMediate]	Initiate one trigger (scan) cycle.
:CONTinuous <b>	Enable (1 or ON) or disable (0 or OFF) continuous initiation of trigger system.
:ABORt	Reset trigger system and go to idle state.
:ARM[:SEQuence[1]]	Subsystem command path to configure scan:
[:LAYer[1]]	Path to program arm layer of scan:
:IMMediate	Loop around control source.
:COUNt <n> | INFinite	Program number of arms (1 to 9999, or INFinite).
:COUNt?	Request programmed arm count.
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal	Select Arm Layer 1 control source.
:SOURce?	Request programmed source (event).
:SIGNal	Loop around control source.
:TCONfigure	Path to configure Triggers.
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous Trigger Link mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:LAYer2	Path to program scan layer of scan:
:IMMediate	Loop around control source.
:COUNt <n> | INFinite	Program number of scans (1 to 9999, or INFinite).
:COUNt?	Request programmed scan count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:DELay?	Request programmed delay period.
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer	Select Arm Layer 2 control source.
:SOURce?	Request programmed source (event).
:SIGNal	Bypass scan control source one time only.
:TIMer <num>	Set timer interval (0 to 99999.999 sec).

Trigger command summary (cont.)

Command	Description
:TIMer?	Request the programmed timer interval.
:TCONfigure	Path to configure Trigger Link:
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:TRIGger[:SEQuence[1]]	Path to program channel layer of scan:
:IMMediate	Scan channels immediately. (Loop around control source.)
:COUNt <n> | INFinite	Program number of channels (1 to 9999, or INFinite).
:AUTo ON/OFF	Use scan-list-length.
:COUNt?	Request programmed channel count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:DELay?	Request programmed delay period.
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer	Select Trigger Layer Control Source.
:SOURce?	Request programmed source (event).
:SIGNal	Bypass channel control source one time only.
:TIMer <num>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Request the programmed timer interval.
:TCONfigure	Path to configure Triggers:
:PROTocol ASYNchronous | SSYNchronous	Select protocol (asynchronous or semi-synchronous Trigger Link.)
:PROTocol?	Request programmed protocol.
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous Trigger Link mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:SSYNchronous	Path to configure semi-synchronous Trigger Link mode:
:LINe <n>	Select trigger line (1 to 6).
:LINe?	Request programmed trigger line.

Note: Command shortform is indicated by the uppercase characters. For example, instead of sending ":arm:layer2:source:immediate", you can send ":arm:lay2:sour:imm".

:INITiate

The scanner cannot arm until the Model 7001 is taken out of the idle state. This command path is used to take the Model 7001 out of the idle state. The commands in this path are as follows:

[:IMMediate]

:INITiate[:IMMediate]

The brackets "[]" enclosing this command indicate that it is implied and need not be sent.

Format

:init

Description

This command takes the Model 7001 out of the idle state. After leaving the trigger (scan) structure, the Model 7001 will return to the idle state.

:CONTinuous <b>

:INITiate:CONTinuous <b>

Parameters

b = 0 or OFF	Disable continuous initiation
b = 1 or ON	Enable continuous initiation

Format

:init:cont b

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Disables continuous initiation
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Disables continuous initiation
:STATus:PRESet	No effect

Description

When continuous initiation is selected (ON), the instrument is taken out of the idle state and will perform a single scan cycle according to how it is programmed. However, at the conclusion of the scan, the instrument will not go into the idle state. It will remain active in Arm Layer 1.

Programming example

The following program statement shows how to use the :INIT command to take the Model 7001 out of the idle state:

```
OUTPUT 707; ":init"
```

:ABORt

Format

:abort

Description

With continuous initiation disabled (:init:cont off), this command will abort a scan. When aborted, the scan will terminate as quickly as possible and return the Model 7001 to the idle state.

Programming example

The following program statement shows how to use the :ABORt command to place the Model 7001 in the idle state:

OUTPUT 707; ":abort"

:ARM[:SEQuence[1]]

This command path is used to configure the arm layer (:LAYer1) and scan layer (LAYer2) of the scan. Note that the second command is enclosed by brackets "[]" indicating that it is implied and need not be sent. The following commands are used in this command path:

[:LAYer[1]]

:ARM[:SEQuence[1]][:LAYer[1]]

The brackets "[]" indicate that this command path is also implied and need not be sent. The following commands in this path are used to configure the arm layer of the scan.

:IMMediate

:ARM[:SEQuence[1]][:LAYer[1]]:IMMediate

Format

:arm:imm

Description

This command is used to bypass the arm control source and is used when you do not wish to wait for the programmed arm event. Keep in mind that the instrument must be waiting for an arm event when this command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the arm control source will be bypassed. This will arm the scan and operation will continue on into the scan layer.

Note that :IMMediate is not an instrument setup command. As soon as this command is executed, it will attempt to arm the scan.

:COUNt <n> | INFinite

:ARM[:SEQuence[1]][:LAYer[1]]:COUNt <n>|INFinite

Parameters

n = 1 to 9999	Finite arm count
INF	Infinite arm count

Formats

:arm:coun n
:arm:coun INF

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Arm count = 1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Arm count = 1
:STATus:PRESet	No effect

Description

This command is used to program the number of times operation will return to Arm Layer 1. After the completion of each scan cycle, operation will loop back up to Arm Layer 1 if programmed for another arm. If arm count is programmed for INFinite, operation will continuously loop back to Arm Layer 1.

:COUNt?

:ARM[:SEQuence[1]][:LAYer[1]]:COUNt?

Format

:arm:coun?

Description

This query command is used to request the programmed arm count. After sending this command and addressing the Model 7001 to talk, the arm count value will be sent to the computer. An arm count value of +9.9e37 indicates that arm count is set to INFinite.

:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal

:ARM[:SEQuence[1]][:LAYer[1]]:SOURce HOLD|IMMediate|MANual BUS|TLINk|EXTernal

Parameters

HOLD	Hold operation in arm layer
IMM	Select immediate arming
MAN	Select manual arm event
BUS	Select GPIB trigger as arm event
TLINK	Select Trigger Link as arm event
EXT	Select External Triggering as arm event

Formats

:arm:sour hold
:arm:sour man
:arm:sour imm
:arm:sour bus

:arm:sour tlink
:arm:sour ext

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Source = IMMediate
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Source = IMMediate
:STATus:PRESet	No effect

Description

This command is used to select Arm Layer 1 control source. With HOLD selected, operation will stop and wait indefinitely in Arm Layer 1. While in HOLD, the scan can be continued by sending the :ARM:IMM command as previously explained. Keep in mind however, that if programmed for another arm, HOLD will again be enforced at the beginning of the next scan cycle (in Arm Layer 1).

With IMM selected (do not confuse :ARM:SOUR IMM with :ARM:IMM), operation will immediately continue to the next layer of operation.

A specific event can be used to control operation through Arm Layer 1. With BUS selected, operation will continue when a GPIB trigger (GET or *TRG) is sent. With TLINK selected, operation will continue when an input trigger via the Trigger Link is received. With EXT selected, operation will continue when an External Trigger is received.

:SOURce?

:ARM[:SEQuence[1]][:LAYer[1]]:SOURce?

Format

:arm:sour?

Description

This query command is used to request the programmed arm control source. After this command is sent and the Model 7001 is addressed to talk, the source message (HOLD, MAN, IMM, BUS, TLIN or EXT) will be sent to the computer.

:SIGNal

:ARM[:SEQuence[1]][:LAYer[1]]:SIGNal

Format

:arm:sign

Description

This command is used to bypass the arm control source and is used when you do not wish to wait for the programmed arm event. Keep in mind that the instrument must be waiting for an arm event when this command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the arm control source will be bypassed. This will arm the scan and operation will continue on into the scan layer.

Note that :SIGNal is not an instrument setup command. As soon as this command is executed, it will attempt to arm the scan.

:TCONfigure

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure

This command path is used to configure triggers for the arm layer of the scan. The following commands are used in this path:

:DIRection SOURce | ACCeptor

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:DIRection SOURce|ACCeptor

Parameters

SOUR	Enable Bypass
ACC	Disable Bypass

Formats

:arm:tcon:dir sour
:arrm:tcon:dir acc

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Direction = Acceptor
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Direction = Acceptor
:STATus:PRESet	No effect

Description

With SOUR selected, an initial bypass through the arm layer is provided at the beginning of a scan cycle. The programmed arm event is not needed. As soon as the Model 7001 is taken out of the idle state, operation will proceed into Arm Layer 2. The instrument does not wait for the programmed event. This bypass only occurs on the first pass through the arm layer. If the scan is programmed for another arm, the instrument will wait in the arm layer until a the programmed arm event occurs. Note that with SOUR selected, the output trigger for the arm layer is enabled.

With ACC selected, the Bypass is disabled. This simply means that the programmed arm event is required to allow operation to proceed into Arm Layer 2. Note that with ACC selected, the output trigger for the arm layer is enabled.

:DIRection?

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:DIRection?

Format

:arm:tcon:dir?

Description

This query command is used to request the programmed direction (SOURce or ACCeptor). After sending this command and addressing the Model 7001 to talk, the direction message (SOUR or ACC) will be sent to the computer.

:ASYNchronous

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:ASYNchronous

This command path is used to configure the following asynchronous trigger lines for Trigger Link.

:ILINe <n>

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:ILINe <n>

Parameters

n = 1 Input is Line #1
n = 2 Input is Line #2
n = 3 Input is Line #3
n = 4 Input is Line #4
n = 5 Input is Line #5
n = 6 Input is Line #6

Format

:arm:tcon:asyn:ilin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Input line = #1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Input line = #1
:STATus:PRESet	No effect

Description

This command is used to select one of the six Trigger Link lines as the input line. Keep in mind that asynchronous Trigger Link input and output (see :OLINe command) cannot share the same line.

If you assign the input to a line that is already being used for the output, an error will occur and the command will be ignored.

:ILINe?

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:ILINe?

Format

arm:tcon:asyn:ilin?

Description

This query command is used to determine which Trigger Link line is being used as the input trigger line. After sending this command and addressing the Model 7001 to talk, the line number (1, 2, 3, 4, 5 or 6) assigned as the input will be sent to the computer.

:OLINe <n>

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:OLINe <n>

Parameters

n = 1 Output is Line #1

n = 2 Output is Line #2
n = 3 Output is Line #3
n = 4 Output is Line #4
n = 5 Output is Line #5
n = 6 Output is Line #6

Format

:arm:tcon:asyn:olin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Output line = #2
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Output line = #2
:STATus:PRESet	No effect

Description

This command is used to select one of the six Trigger Link lines as the output line. Keep in mind that asynchronous Trigger Link output and input (see :ILINe command) cannot share the same line.

If you assign the output to a line that is already being used for the output, an error will occur and the command will be ignored.

:OLINe?

:ARM[:SEQuence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:OLINe?

Format

arm:tcon:asyn:olin?

Description

This query command is used to determine which Trigger Link line is being used as the output trigger line. After sending this command and addressing the Model 7001 to talk, the line number (1, 2, 3, 4, 5 or 6) assigned as the output will be sent to the computer. Note that if the Trigger Link (TLIN) arm control source is not currently selected, the value zero (0) will instead be sent to the computer.

Programming example

The following programming example demonstrates how to use :LAYer1 commands of the :ARM subsystem to program the arm layer of the scan:

```
10 OUTPUT 707; ":arm:sour man;coun 2;tcon:dir sour"
20 OUTPUT 707; ":arm:sour?;coun?;tcon:dir?"
30 ENTER 707; A$
40 PRINT A$
50 END
```

Line 10 Three commands on this line; :SOURce selects manual arm control source, COUNt selects an arm count of two, and DIRection enables the source bypass.

Line 20 Three query commands on this line; :SOURce? requests the programmed arm control source, :COUNt? requests the programmed arm count, and :DIRection? requests the status of the source bypass.

Line 30 Addresses the Model 7001 to talk.

Line 40 Displays the query messages in the order that they were sent (MAN, 2, SOUR).

:LAYer2

:ARM[:SEQuence[1]]:LAYer2

The following commands in this path are used to configure the scan layer of the scan.

:IMMediate

:ARM[:SEQuence[1]]:LAYer2:IMMediate

Format

:arm:lay2:imm

Description

This command is used to bypass the scan control source and the scan layer delay (see :LAYer2:DELay). It is used when you do not wish to wait for the programmed scan event. Keep in mind that the instrument must be waiting for a scan event when this command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the scan control source and scan delay will be bypassed. This will enable the scan and operation will continue on into the channel layer.

Note that :IMMediate is not an instrument setup command. As soon as this command is executed, it will attempt to enable the scan.

:COUNt <n> | INFinite

:ARM[:SEQuence[1]]:LAYer2:COUNt <n>|INFinite

Parameters

n = 1 to 9999	Finite scan count
INF	Infinite scan count

Formats

:arm:lay2:coun n
:arm:lay2:coun INF

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Scan count = 1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Scan count = INFinite
:STATus:PRESet	No effect

Description

This command is used to program the number of times the scan can be repeated. After the completion of each channel scan, operation will loop back up to Arm Layer 2 if programmed for another scan. If scan count is programmed for INFinite, operation will continuously loop back to Arm Layer 2.

:COUNt?

:ARM[:SEQuence[1]]:LAYer2:COUNt?

Format :arm:lay2:coun?

Description This query command is used to request the programmed scan count. After sending this command and addressing the Model 7001 to talk, the scan count value will be sent to the computer. A scan count value of +9.9e37 indicates that the scan count is set to IN-Finite.

:DELay <num>

:ARM[:SEQuence[1]]:LAYer2:DELay <num>

Parameters num = 0 to 99999.999 seconds Delay Period

Format :arm:lay2:del num

Description This delay period is used to delay operation in Arm Layer 2. After the scan event is detected, the instrument will wait until the DELay times out before continuing on to the Trigger Layer. This delay is in effect for all programmed scans.

:DELay?

:ARM[:SEQuence[1]]:LAYer2:DELay?

Format :arm:lay2:del?

Description This query command is used to request the programmed DELay for Arm Layer 2. After sending this command and addressing the Model 7001 to talk, the delay period (in seconds) will be sent to the computer.

:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer

:ARM[:SEQuence[1]]:LAYer2:SOURce HOLD|IMMediate|MANual|BUS|TLINk|EXTernal|TIMer

Parameters

HOLD	Hold operation in Arm Layer 2
IMM	Select immediate scanning
TIM	Select timer as scan event
MAN	Select manual scan event
BUS	Select GPIB trigger as scan event
TLINK	Select Trigger Link as scan event
EXT	Select External Triggering as scan event

Formats

```
:arm:lay2:sour hold
:arm:lay2:sour man
:arm:lay2:sour imm
:arm:lay2:sour tim
:arm:lay2:sour bus
:arm:lay2:sour tlink
:Arm:lay2:sour ext
```

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Source = IMMediate
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Source = IMMediate
:STATus:PRESet	No effect

Description

This command is used to select the control source for Arm Layer 2. With HOLD selected, operation will stop and wait indefinitely in Arm Layer 2. While in HOLD, the scan can be continued by sending the :ARM:LAY2:IMM command as previously explained. Keep in mind however, that if programmed for another scan, HOLD will again be enforced at the beginning of the next scan (in Arm Layer 2).

With IMM selected (do not confuse :ARM:LAY2:SOUR IMM with :ARM:LAY2:IMM), the scan will immediately continue to the next layer of operation.

A specific event can be used to control the scan. With TIM selected, a scan event occurs at the beginning of the timer interval and every time it times out. For example, if the timer is programmed for a 30 second interval, the first scan event occurs immediately. Subsequent scan events then occur every 30 seconds. The interval for the timer is set using the :LAYer2:TIMer command.

With BUS selected, operation will continue when a GPIB trigger (GET or *TRG) is sent. With TLINK selected, operation will continue when an input trigger via the Trigger Link is received. With EXT selected, operation will continue when an External Trigger is received.

:SOURce?

:ARM[:SEQuence[1]]:LAYer2:SOURce?

Format

```
:arm:lay2:sour?
```

Description

This query command is used to request the programmed scan control source. After this command is sent and the Model 7001 is addressed to talk, the source message (HOLD, MAN, IMM, TIM, BUS, TLIN or EXT) will be sent to the computer.

:SIGNal

:ARM[:SEQuence[1]]:LAYer2:SIGNal

Format

```
:arm:lay2:sign
```

Description

This command is used to bypass the scan control source and is used when you do not wish to wait for the programmed scan event. Note however, that the delay (see :LAYer2:DELay) is not bypassed. The instrument must be waiting for a scan event when this command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the scan control source will be bypassed. If there is a programmed scan delay, the instrument will wait until the delay times out and then continue on into the channel layer.

Note that :SIGNal is not an instrument setup command. As soon as this command is executed, it will attempt to loop around the control source.

:TIMer <num>

:ARM[:SEQuence[1]]:LAYer2:TIMer <num>

Parameter

num = 1 to 99999.999 Interval in seconds

Format

:arm:lay2:tim num

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Interval = 0.001 sec
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Interval = 0.001 sec
:STATus:PRESet	No effect

Description

This command sets the interval of the timer for Arm Layer 2. Note that the timer is in effect only if the timer is the selected control source (see :ARM:LAY2:SOURce).

:TIMer?

:ARM[:SEQuence[1]]:LAYer2:TIMer?

Format

:arm:lay2:tim?

Description

This query command is used to request the programmed interval for Arm Layer 2 timer. After this command is sent and the Model 7001 is addressed to talk, the interval (in seconds) will be sent to the computer.

:TCONfigure

:ARM[:SEQuence[1]]:LAYer2:TCONfigure

This command path is used to configure triggers for Arm Layer 2. The following commands are used in this path:

:DIRection SOURce | ACCeptor

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:DIRection SOURce|ACCeptor

Parameters

SOUR	Enable Bypass
ACC	Disable Bypass

Formats

:arm:lay2:tcon:dir sour
:arm:lay2:tcon:dir acc

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Direction = Acceptor
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Direction = Acceptor
:STATus:PRESet	No effect

Description

With SOUR selected, an initial bypass through Arm Layer 2 is provided. The scan does not wait for the programmed scan event. This bypass only occurs on the first pass through Arm Layer 2. If programmed for another scan, the instrument will wait in Arm Layer 2 until the programmed event occurs. Note that with SOUR selected, the output trigger for Arm Layer 2 is enabled.

With ACC selected, the Bypass is disabled. This simply means that the programmed scan event is required to allow operation to proceed into the Trigger Layer. Note that with ACC selected, the output trigger for Arm Layer 2 is suppressed.

:DIRection?

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:DIRection?

Format

:arm:lay2:tcon:dir?

Description

This query command is used to request the programmed direction (SOURce or ACCeptor). After sending this command and addressing the Model 7001 to talk, the direction message (SOUR or ACC) will be sent to the computer.

:ASYNchronous

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:ASYNchronous

This command path is used to configure the following asynchronous trigger lines for Trigger Link.

:ILINe <n>

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:ASYNchronous:ILINe <n>

Parameters

n = 1 Input is Line #1
n = 2 Input is Line #2
n = 3 Input is Line #3
n = 4 Input is Line #4
n = 5 Input is Line #5
n = 6 Input is Line #6

Format

:arm:lay2:tcon:asyn:ilin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Input line = #1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Input line = #1
:STATus:PRESet	No effect

Description

This command is used to select one of the six Trigger Link lines as the input line. Keep in mind that asynchronous Trigger Link input and output (see :OLINe command) cannot share the same line.

If you assign the input to a line that is already being used for the output, an error will occur and the command will be ignored.

:ILINe?

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:ASYNchronous:ILINe?

Format

arm:lay2:tcon:asyn:ilin?

Description

This query command is used to determine which Trigger Link line is being used as the input trigger line. After sending this command and addressing the Model 7001 to talk, the line number (1, 2, 3, 4, 5 or 6) assigned as the input will be sent to the computer. Note that if the Trigger Link (TLIN) arm control source is not currently selected, the value zero (0) will instead be sent to the computer.

:OLINe <n>

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:ASYNchronous:OLINe <n>

Parameters

n = 1 Output is Line #1
n = 2 Output is Line #2
n = 3 Output is Line #3
n = 4 Output is Line #4
n = 5 Output is Line #5
n = 6 Output is Line #6

Format

:arm:lay2:tcon:asyn:olin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Output line = #2
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Output line = #2
:STATus:PRESet	No effect

Description

This command is used to select one of the six Trigger Link lines as the output line. Keep in mind that asynchronous Trigger Link output and input (see :ILINe command) cannot share the same line.

If you assign the output to a line that is already being used for the output, an error will occur and the command will be ignored.

:OLINe?

:ARM[:SEQuence[1]]:LAYer2:TCONfigure:ASYNchronous:OLINe?

Format

arm:lay2:tcon:asyn:olin?

Description

This query command is used to determine which Trigger Link line is being used as the output trigger line. After sending this command and addressing the Model 7001 to talk, the line number (1, 2, 3, 4, 5 or 6) assigned as the output will be sent to the computer.

Programming example

The following programming example demonstrates how to use :LAYer2 commands of the :ARM subsystem to program the scan layer of the scan:

```
10 OUTPUT 707; ":arm:lay2:sour tim;tim 20;coun 1;tcon:dir sour"
20 OUTPUT 707; ":arm:lay2:sour?;tim?;coun?;tcon:dir?"
30 ENTER 707; A$
40 PRINT A$
50 END
```

Line 10 Four commands on this line; :SOURce selects the timer as the scan control source, TIMer sets to timer to 20 seconds, COUNt selects a scan count of one, and DIRection enables the source bypass.

Line 20 Four query commands on this line; :SOURce? requests the programmed scan control source, TIMer? requests the timer interval, :COUNt? requests the programmed scan count, and :DIRection? requests the status of the source bypass.

Line 30 Addresses the Model 7001 to talk.

Line 40 Displays the query messages in the order that they were sent (TIM, 20.000, 1, SOUR).

:TRIGger[:SEQuence[1]]

The brackets "[]" enclosing :SEQuence1 indicate that the command is implied and need not be sent. The following commands in this path are used to configure the channel layer (:TRIGger) of the scan.

:IMMediate

TRIGger[:SEQuence[1]]:IMMediate

Format

:trig:imm

Description

This command is used to bypass the channel control source and the Trigger Layer delay (see :TRIGger:DELay). It is used when you do not wish to wait for the programmed channel event. Keep in mind that the instrument must be waiting for a channel event when this command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the control source and delay will be bypassed, and the next channel in the scan will close.

Note that :IMMediate is not an instrument setup command. As soon as this command is executed, it will attempt to close the next channel in the scan.

:COUNt <n> | INFinite

:TRIGger[:SEQuence[1]]:COUNt <n>|INFinite

Parameters

n = 1 to 9999	Finite channel count
INF	Infinite channel count

Formats

:trig:coun n
:trig:coun INF

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Channel count = 1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Channel count = scan-list-length

:STATus:PRESet No effect

Description

This command is used to program the number of channels to be scanned. Typically, the number of channels (n) should be programmed to equal the number of channels in the scan list. When using the scan-list-length as the channel count, each channel in the scan list will be closed once for every programmed scan. The scan-list-length can be determined by using the :ROUTe:SCAN:POINts? query command (see ROUTe subsystem).

If you select a channel count that is less than the scan-list-length, the first scan will end after that number of channels have been scanned. If programmed for another scan, it will continue from the last scanned channel.

If you select a finite channel count that is greater than the scan-list-length, the first scan will scan all the channels in the scan list, and then loop back to the beginning of the scan list and repeat the scan until the channel count is satisfied. If programmed for another scan, it will continue from the last scanned channel.

If you select an INFinite channel count, the scan will loop back to the beginning of the scan list after all the channels in the list have been scanned. This process will continue indefinitely.

:AUTO ON/OFF

:TRIGger[:SEQuence[1]]:COUNt <n>|INFinite:AUTO ON/OFF

Parameters

ON Use scan-list-length for channel count
OFF Use <n> (1-9999) or INF (infinite) for channel count

Format

:trig:coun:auto on
:trig:coun:auto off

Defaults

Power-up	Saved power-on default
*RST	OFF
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	ON
:STATus:PRESet	No effect

Description

With the command :trig:coun:auto on, you set the channel count to the scan-list-length. If the command :trig:coun:auto off is sent, the channel count is set to the parameter of :trig:coun (1-9999 or infinite).

:COUNt?

:TRIGger[:SEQuence[1]]:COUNt?

Format

:trig:coun?

Description

This query command is used to request the programmed channel count. After sending this command and addressing the Model 7001 to talk, the channel count value will be

sent to the computer. A channel count value of +9.9e37 indicates that the channel count is set to INFinite.

:DELay <num>

:TRIGger[:SEQuence[1]]:DELay <num>

Parameter num = 0 to 99999.999 seconds Delay Period

Format :trig:del num

Description This delay period is used to delay the closing of each channel in the scan. After the channel control source occurs, the instrument will wait until the DELay times out before closing the next channel. This delay is in effect for every channel in the scan.

:DELay?

:TRIGger[:SEQuence[1]]:DELay?

Format :trig:del?

Description This query command is used to request the programmed DELay for the Trigger Layer. After sending this command and addressing the Model 7001 to talk, the delay period (in seconds) will be sent to the computer.

:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer

:TRIGger[:SEQuence[1]]:SOURce HOLD|IMMediate|MANual|BUS|TLINk|EXTernal|TIMer

Parameters

HOLD	Hold operation in Trigger Layer
IMM	Select immediate channel scan
TIM	Select timer as channel event
MAN	Select manual channel event
BUS	Select GPIB trigger as channel event
TLINK	Select Trigger Link as channel event
EXT	Select External Triggering as channel event

Formats

:trig:sour hold
:trig:sour man
:trig:sour imm
:trig:sour tim
:trig:sour bus
:trig:sour tlink
:trig:sour ext

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Source = IMMediate
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Source = MANual
:STATus:PRESet	No effect

Description

This command is used to select the source for controlling the channel scan. With HOLD selected, operation will stop and wait indefinitely in the Trigger Layer. While in HOLD, the channel scan can be continued by sending the :TRIG:IMM command as previously explained. Keep in mind that HOLD will again be enforced for the next channel.

With IMM selected (do not confuse :TRIG:SOUR IMM with :TRIG:IMM), each channel will be scanned immediately and not wait for any particular event.

A specific event can be used control the channel scan. When using TIM, the first channel is scanned immediately, and subsequent channels are scanned every time the timer times out. The interval for the timer is set using the :TRIGger:TIMer command.

With BUS selected, each channel is scanned when a GPIB trigger (GET or *TRG) is sent. With TLINK selected, each channel is scanned when an input trigger via the Trigger Link is received. With EXT selected, the each channel is scanned when an External Trigger is received.

:SOURce?

:TRIGger[:SEQuence[1]]:SOURce?

Format

:trig:sour?

Description

This query command is used to request the programmed channel control source. After this command is sent and the Model 7001 is addressed to talk, the source message (HOLD, MAN, IMM, TIM, BUS, TLIN or EXT) will be sent to the computer.

:SIGNal

:TRIGger[:SEQuence[1]]:SIGNal

Format

:trig:sign

Description

This command is used to bypass the channel control source and is used when you do not wish to wait for the programmed channel event. Note however, that the Trigger Layer delay (see :TRIGger:DELay) is not bypassed. The instrument must be waiting for a channel event when this command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the channel control source will be bypassed. If there is a programmed channel delay, the instrument will wait until the delay times out and will then close the next channel in the scan.

Note that :SIGNal is not an instrument setup command. As soon as this command is executed, it will attempt to close the next channel in the scan.

:TIMer <num>

:TRIGger[:SEQuence[1]]:TIMer <num>

Parameter num = 1 to 99999.999 Interval in seconds

Format :trig:tim num

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Interval = 0.001 sec
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Interval = 0.001 sec
:STATus:PRESet	No effect

Description This command sets the interval of the timer for the Trigger Layer. Note that the timer is in effect only if the timer is the selected control source (see :TRIGger:TIMer).

:TIMer?

:TRIGger[:SEQuence[1]]:TIMer?

Format :trig:tim?

Description This query command is used to request the programmed interval of the Trigger Layer timer. After this command is sent and the Model 7001 is addressed to talk, the interval (in seconds) will be sent to the computer.

:TCONfigure

:TRIGger[:SEQuence[1]]:TCONfigure

This command path is used to configure triggers. The following commands are used in this path:

:PROTocol ASYNchronous | SSYNchronous

:TRIGger[:SEQuence[1]]:TCONfigure:PROTocol ASYNchronous|SSYNchronous

Parameters

ASYNchronous	Asynchronous Trigger Link Mode
SSYNchronous	Semi-synchronous Trigger Link Mode

Formats

:trig:tcon:prot asyn
:trig:tcon:prot ssyn

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Protocol = Asynchronous
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Protocol = Asynchronous
:STATus:PRESet	No effect

Description

This command is used to select the protocol for the Trigger Link. With asynchronous, separate trigger lines are used for input and output triggers. With semi-synchronous, a single trigger line is used for both input and output triggers. See paragraph 4.11 for details on the Trigger Link.

:PROTocol?

:TRIGger[:SEQuence[1]]:TCONfigure:PROTocol?

Format

:trig:tcon:prot?

Description

This query command is used to request the programmed Trigger Link protocol. After sending this command and addressing the Model 7001 to talk, protocol message (ASYN or SSYN) will be sent to the computer.

:DIRection SOURce | ACCeptor

:TRIGger[:SEQuence[1]]:TCONfigure:DIRection SOURce|ACCeptor

Parameters

SOUR	Enable Bypass
ACC	Disable Bypass

Formats

:trig:tcon:dir sour
:trig:tcon:dir acc

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Direction = Acceptor
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Direction = Source
:STATus:PRESet	No effect

Description

With SOUR selected, an initial bypass around the required channel source event is required. This means the first channel in the scan list will close as soon as the scan is armed and enabled. It does not wait for the programmed channel event. This bypass only occurs for the first channel in the scan. The next channels will then be controlled by the programmed channel event.

With ACC selected, the Bypass is disabled. This simply means that the channel scan is controlled by the programmed channel event.

:DIRection?

:TRIGger[:SEQuence[1]]:TCONfigure:DIRection?

Format

:trig:tcon:dir?

Description

This query command is used to request the programmed direction (SOURce or ACCeptor). After sending this command and addressing the Model 7001 to talk, the direction message (SOUR or ACC) will be sent to the computer.

:ASYNchronous

:TRIGger[:SEQuence[1]]:TCONfigure:ASYNchronous

This command path is used to configure the following asynchronous trigger lines for Trigger Link.

:ILINe <n>

:TRIGger[:SEQuence[1]]:TCONfigure:ASYNchronous:ILINe <n>

Parameters

n = 1 Input is Line #1
n = 2 Input is Line #2
n = 3 Input is Line #3
n = 4 Input is Line #4
n = 5 Input is Line #5
n = 6 Input is Line #6

Format

:trig:tcon:asyn:ilin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Input line = #1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Input line = #1
:STATus:PRESet	No effect

Description

This command is used to select one of the six Trigger Link lines as the input line. Keep in mind that asynchronous Trigger Link input and output (see :OLINe command) cannot share the same line.

If you assign the input to a line that is already being used for the output, an error will occur and the command will be ignored.

:ILINe?

:TRIGger[:SEQuence[1]]:TCONfigure:ASYNchronous:ILINe?

Format

arm:trig:tcon:asyn:ilin?

Description

This query command is used to determine which Trigger Link line is being used as the input trigger line. After sending this command and addressing the Model 7001 to talk, the line number (1, 2, 3, 4, 5 or 6) assigned as the input will be sent to the computer.

:OLINe <n>

:TRIGger[:SEQuence[1]]:TCONfigure:ASYNchronous:OLINe <n>

Parameters

n = 1 Output is Line #1
n = 2 Output is Line #2
n = 3 Output is Line #3
n = 4 Output is Line #4
n = 5 Output is Line #5
n = 6 Output is Line #6

Format

:trig:tcon:asyn:olin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Output line = #2
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Output line = #2
:STATus:PRESet	No effect

Description

This command is used to select one of the six Trigger Link lines as the output line. Keep in mind that asynchronous Trigger Link output and input (see :ILINe command) cannot share the same line.

If you assign the output to a line that is already being used for the output, an error will occur and the command will be ignored.

:OLINe?

:TRIGger[:SEQuence[1]]:TCONfigure:ASYNchronous:OLINe?

Format

:trig:tcon:asyn:olin?

Description

This query command is used to determine which Trigger Link line is being used as the output trigger line. After sending this command and addressing the Model 7001 to talk, the line number (1, 2, 3, 4, 5 or 6) assigned as the output will be sent to the computer.

:SSYNchronous

:TRIGger[:SEQuence[1]]:TCONfigure:SSYNchronous

This command path is used to select a trigger line for the semi-synchronous Trigger Link mode.

:ILINe <n>

:TRIGger[:SEQuence[1]]:TCONfigure:SSYNchronous:ILINe <n>

Parameters

n = 1 Trigger line #1
n = 2 Trigger line #2
n = 3 Trigger line #3
n = 4 Trigger line #4
n = 5 Trigger line #5
n = 6 Trigger line #6

Format

:trig:tcon:ssyn:lin n

Defaults

Power-up	Selects saved default (see *SAV)
*RST	Trigger line = #1
*CLS	No effect
DCL, SDC	No effect
:SYSTem:PRESet	Trigger line = #1
:STATus:PRESet	No effect

Description

This command is used to select one of the six trigger lines for the semi-synchronous Trigger Link.

:ILINe?

:TRIGger[:SEQuence[1]]:TCONfigure:SSYNchronous:ILINe?

Format

:trig:tcon:ssyn:line?

Description

This query command is used to request the trigger line number that is selected for the semi-synchronous Trigger Link mode. After sending this command and addressing the Model 7001 to talk, the trigger line number will be sent to the computer.

Programming example

The following programming example demonstrates how to use commands of the :TRIGger subsystem to program the channel layer of the scan:

```
10  OUTPUT 707; ":trig:sour tim;tim 0.5;coun 15"
20  OUTPUT 707; ":trig:sour?;tim?coun?"
30  ENTER 707; A$
40  PRINT A$
50  END
```

Line 10 Three commands on this line; :SOURce selects the timer as the channel control source, TIMer sets to timer to 0.5 seconds, and COUNt selects an channel count of 15.

Line 20 Three query commands on this line; :SOURce? requests the programmed channel control source, TIMer? requests the timer interval, and :COUNt? requests the programmed channel count.

Line 30 Addresses the Model 7001 to talk.

Line 40 Displays the query messages in the order that they were sent (TIM, 0.500, 15).

Appendices

7001 Switching Cards

Appendices

APPENDICIES

Appendix A — IEEE-488.2 Common Commands

Appendix B — SCPI Command Subsystems

Appendix C — Interface Function Codes

Appendix D — ASCII Character Codes and IEEE-488 Multiline Interface Command Messages

Appendix E — Controller Programs

Appendix F — Menu Structures

Appendix G — IEEE-488 Bus Overview

Appendix H — IEEE-488 Conformance Information

Appendix I — SCPI Conformance Information

A

IEEE-488.2 Common Commands and Queries

Table A-1
IEEE-488.2 common commands and queries

Mnemonic	Name	Description
*CLS	Clear status	Clears all event registers, and Error Queue.
*ESE <n>	Event status enable command	Sets the contents of the Standard Event Status Enable Register.
*ESE?	Event status enable query	Request the programmed value of the Standard Event Status Enable Register.
*ESR?	Event status register query	Request the programmed value of the Standard Event Status Register and clears it.
*IDN?	Identification query	Request the manufacturer, model number, serial number, and firmware revision levels of the unit.
*OPC	Operation complete command	Sets the Operation Complete bit in the Standard Event Status Register after all pending commands have been executed.
*OPC?	Operation complete query	Places an ASCII "1" into the output queue when all pending selected device operations have been completed.
*OPT?	Option identification query	Request the assigned model number for each slot.
*RCL <n>	Recall command	Returns the Model 7001 to the setup configuration stored in the designated memory location.
*RST	Reset command	Returns the Model 7001 to the *RST default conditions.
*SAV <n>	Save command	Saves the current setup configuration to the designated memory location.

Table A-1 (continued)
IEEE-488.2 common commands and queries

Mnemonic	Name	Description
*SRE <n>	Service request enable command	Sets the contents of the Service Request Enable Register.
*SRE?	Service request enable query	The Model 7001 returns the value of the Service Request Enable Register.
*STB?	Read status byte query	Returns the value of the Status Byte Register.
*TRG	Trigger command	This command issues a bus trigger which has the same effect as group execute trigger (GET) command.
*TST?	Self-test query	When this query is sent, the Model 7001 will perform a checksum test on ROM and return the results.
*WAI	Wait-to-continue command	Wait until all previous commands are executed.

B

SCPI Command Subsystems

Table B-1
DISPlay command summary

Command	Description
:DISPlay	
[:WINDow[1]]	Path to locate message to top portion of display
:TEXT	Path to control user text messages:
:DATA <a>	Define ASCII message "a" using up to 20 characters.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message.
:STATe?	Request message status (enabled or disabled).
:WINDow2	Path to locate message to bottom portion of display:
:TEXT	Path to control user text messages:
:DATA <a>	Define ASCII message "a" using up to 32 characters.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message.
:STATe?	Request message status (enabled or disabled).
:SMESsage <b>	Enable (1 or ON) or disable (0 or OFF) displayed status messages.
:SMESsage?	Request state of status message display.

Table B-2
OUTPut command summary

Command	Description
:OUTPut	
:TTLn	Path and command to specify output line "n" (1-4):
:LSENse AHIGh | ALOW	Set polarity; active high (AHIG) or active low (ALOW).
:LSENse?	Request polarity of specified output line (n).

Table B-3
ROUTe command summary

Command	Description
[:ROUTe]	
:CLOSe <list>	Path and command to close specified channels:
:STATe?	Request channels that are closed.
:OPEN <list> | ALL	Open specified (or all) channels.
:SCAN <list>	Path and command to specify channel list:
:POINts?	Request number of channels in the scan list.
:SCAN?	Request the programmed scan list.
:FCHannels <list>	Specifies channels that cannot be closed (forbidden).
:FCHannels?	Request list of restricted channels.
:CONFigure:	Configuration command path:
:SCHannel <b>	Enable (1 or ON) or disable (0 or OFF) Single Channel.
:SCHannel?	Request status of Single Channel mode.
:CPAir <b>	Enable (1 or ON) or disable (0 or OFF) Channel Pairing.
:CPAir?	Request status of Channel Pairing.
:SLOT1	Path to configure CARD 1:
:CTYPE <type>	Specify the card type installed in the slot.
:CTYPE?	Request the card type installed in the slot.
:POLE <n>	Select pole mode (1, 2 or 4).
:POLE?	Request the programmed number of poles.
:STIMe <num>	Set relay settling time in seconds (0 to 99999.999).
:STIMe?	Request the programmed relay settling time.
:SLOT2	Path to configure CARD 2:
:CTYPE <type>	Specify the card type installed in the slot.
:CTYPE?	Request the card type installed in the slot.
:POLE <n>	Select pole mode (1, 2 or 4).
:POLE?	Request the programmed number of poles.
:STIMe <num>	Set relay settling time in seconds (0 to 99999.999).
:STIMe?	Request the programmed relay settling time.
:MEMory	Path to program memory:
:SAVe M<num>	Saves channel pattern at memory location (1-100).
:RECall M<num>	Recalls channel pattern from memory location (1-100).

Table B-4
SENSe command summary

Command	Description
:SENSe[1]	
:TTL1	Command path for input port.
:DATA?	Read digital input port.

Table B-5
SOURce command summary

Command	Description
:SOURce	Command path to program digital output port bits:
:TTL1	Path to program Bit 1 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 1.
:TTL2	Path to program Bit 2 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 2.
:TTL3	Path to program Bit 3 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 3.
:TTL4	Path to program Bit 4 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 4.

Table B-6
STATus command summary

Command	Description
:STATus	
:OPERation	Path to control operation event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 to 1122).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 to 1122).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 to 1122).
:ENABle?	Read the enable register.
:ARM	Path to control arm event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 or 2).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 or 2).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 or 2).
:ENABle?	Read the enable register.
:SEQuence	Path to control the sequence event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 to 6).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 to 6).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 to 6).
:ENABle?	Read the enable register.
:TRIGger	Path to control trigger event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 or 2).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 or 2).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 or 2).
:ENABle?	Read the enable register.
:PRESet	Return status registers to default states.
:QUEue	Path to access error queue:
[:NEXT]?	Request most recent error message.
:ENABle <list>	Specify error and status messages for queue.

Table B-6 (continued)
STATus command summary

Command	Description
:QUEStionable	Path to control questionable event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register.
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register.
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register.
:ENABle?	Read the enable register.

Table B-7
SYSTem command summary

Command	Description
:SYSTem	
:ERRor?	Request message from Error/Status Queue.
:POSetup RST | PRESet | SAV0 | SAV1 | SAV2 | SAV3 | SAV4 | SAV5 | SAV6 | SAV7 | SAV8 | SAV9	Select Power-on setup.
:POSetup?	Request the power-on setup.
:PRESet	Return instrument to default conditions.
:VERSion?	Request the revision level of the SCPI Standard.?

Table B-8
Trigger command summary

Command	Description
:INITiate	Subsystem command path:
[:IMMediate]	Initiate one trigger (scan) cycle.
:CONTinuous <b>	Enable (1 or ON) or disable (0 or OFF) continuous initiation of trigger system.
:ABORt	Reset trigger system and go to idle state.
:ARM[:SEQuence[1]]	Subsystem command path to configure scan:
[:LAYer[1]]	Path to program arm layer of scan:
:IMMediate	Loop around control source.
:COUNt <n> | INFinite	Program number of arms (1 to 9999, or INFinite).
:COUNt?	Request programmed arm count.
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal	Select Arm Layer 1 control source.
:SOURce?	Request programmed source (event).
:SIGNal	Loop around control source.
:TCONfigure	Path to configure Triggers.
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous Trigger Link mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:LAYer2	Path to program scan layer of scan:
:IMMediate	Loop around control source.
:COUNt <n> | INFinite	Program number of scans (1 to 9999, or INFinite).
:COUNt?	Request programmed scan count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:DELay?	Request programmed delay period.
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer	Select Arm Layer 2 control source.
:SOURce?	Request programmed source (event).
:SIGNal	Bypass scan control source one time only.
:TIMer <num>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Request the programmed timer interval.

Table B-8 (continued)
Trigger command summary

Command	Description
:TCONfigure	Path to configure Trigger Link:
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:TRIGger[:SEQuence[1]]	Path to program channel layer of scan:
:IMMediate	Scan channels immediately. (Loop around control source.)
:COUNt <n> | INFinite	Program number of channels (1 to 9999, or INFinite).
:AUTO ON/OFF	Use scan-list-length.
:COUNt?	Request programmed channel count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:DELay?	Request programmed delay period.
:SOURce HOLD | IMMediate | MANual | BUS | TLINk | EXTernal | TIMer	Select Trigger Layer Control Source.
:SOURce?	Request programmed source (event).
:SIGNal	Bypass channel control source one time only.
:TIMer <num>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Request the programmed timer interval.
:TCONfigure	Path to configure Triggers:
:PROTocol ASYNchronous | SSYNchronous	Select protocol (asynchronous or semi-synchronous Trigger Link.)
:PROTocol?	Request programmed protocol.
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous Trigger Link mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:SSYNchronous	Path to configure semi-synchronous Trigger Link mode:
:LINe <n>	Select trigger line (1 to 6).
:LINe?	Request programmed trigger line.

C

Interface Function Codes

The interface function codes, which are part of the IEEE-488 standards, define an instrument's ability to support various interface functions and should not be confused with programming commands found elsewhere in this manual. The interface function codes for the Model 7001 are listed in Table C-1. The codes define Model 7001 capabilities as follows:

SH (Source Handshake Function) — SH1 defines the ability of the instrument to initiate the transfer of message/data over the data bus.

AH (Acceptor Handshake Function) — AH1 defines the ability of the instrument to guarantee proper reception of message/data transmitted over the data bus.

T (Talker Function) — The ability of the instrument to send data over the bus to other devices is provided by the T function. Instrument talker capabilities (T5) exist only after the instrument has been addressed to talk.

L (Listener Function) — The ability for the instrument to receive device-dependent data over the bus from other devices is provided by the L function. Listener capabilities (L4) of the instrument exist only after it has been addressed to listen.

SR (Service Request Function) — SR1 defines the ability of the instrument to request service from the controller.

RL (Remote-Local Function) — RL1 defines the ability of the instrument to be placed in the remote or local modes.

PP (Parallel Poll Function) — The instrument does not have parallel polling capabilities (PP0).

DC (Device Clear Function) — DC1 defines the ability of the instrument to be cleared (initialized).

DT (Device Trigger Function) — DT1 defines the ability of the Model 182 to have readings triggered.

C (Controller Function) — The instrument does not have controller capabilities (C0).

TE (Extended Talker Function) — The instrument does not have extended talker capabilities (TE0).

LE (Extended Listener Function) — The instrument does not have extended listener capabilities (LE0).

E (Bus Driver Type) — The instrument has open-collector bus drivers (E1).

Table C-1
Model 7001 interface function codes

Code	Interface function
SH1	Source Handshake capability
AH1	Acceptor Handshake capability
T5	Talker (basic talker, serial poll, unaddressed to talk on LAG)
L4	Listener (basic listener, unaddressed to listen on TAG)
SR1	Service Request capability
RL1	Remote/Local capability
PP0	No Parallel Poll capability
DC1	Device Clear capability
DT1	Device Trigger capability
C0	No Controller capability
E1	Open collector bus drivers
TE0	No Extended Talker capability
LE0	No Extended Listener capability

D

ASCII Character Codes and IEEE-488 Multiline Interface Command Messages

Decimal	Hexadecimal	ASCII	IEEE-488 Messages*
0	00	NUL	
1	01	SOH	GTL
2	02	STX	
3	03	ETX	
4	04	EOT	SDC
5	05	ENQ	PPC
6	06	ACK	
7	07	BEL	
8	08	BS	GET
9	09	HT	TCT
10	0A	LF	
11	0B	VT	
12	0C	FF	
13	0D	CR	
14	0E	SO	
15	0F	SI	
16	10	DLE	
17	11	DC1	LLO
18	12	DC2	
19	13	DC3	
20	14	DC4	DCL
21	15	NAK	PPU
22	16	SYN	
23	17	ETB	
24	18	CAN	SPE
25	19	EM	SPD
26	1A	SUB	
27	1B	ESC	
28	1C	FS	
29	1D	GS	
30	1E	RS	
31	1F	US	

* Message sent or received with ATN true.

Decimal	Hexadecimal	ASCII	IEEE-488 Messages*
32	20	SP	MLA 0
33	21	!	MLA 1
34	22	"	MLA 2
35	23	#	MLA 3
36	24	$	MLA 4
37	25	%	MLA 5
38	26	&	MLA 6
39	27	'	MLA 7
40	28	(	MLA 8
41	29	)	MLA 9
42	2A	*	MLA 10
43	2B	+	MLA 11
44	2C	,	MLA 12
45	2D	-	MLA 13
46	2E	.	MLA 14
47	2F	/	MLA 15
48	30	0	MLA 16
49	31	1	MLA 17
50	32	2	MLA 18
51	33	3	MLA 19
52	34	4	MLA 20
53	35	5	MLA 21
54	36	6	MLA 22
55	37	7	MLA 23
56	38	8	MLA 24
57	39	9	MLA 25
58	3A	:	MLA 26
59	3B	;	MLA 27
60	3C	<	MLA 28
61	3D	=	MLA 29
62	3E	>	MLA 30
63	3F	?	UNL

* Message sent or received with ATN true. Numbers shown represent primary address resulting in MLA (My Listen Address).

Decimal	Hexadecimal	ASCII	IEEE-488 Messages*
64	40	@	MTA 0
65	41	A	MTA 1
66	42	B	MTA 2
67	43	C	MTA 3
68	44	D	MTA 4
69	45	E	MTA 5
70	46	F	MTA 6
71	47	G	MTA 7
72	48	H	MTA 8
73	49	I	MTA 9
74	4A	J	MTA 10
75	4B	K	MTA 11
76	4C	L	MTA 12
77	4D	M	MTA 13
78	4E	N	MTA 14
79	4F	O	MTA 15
80	50	P	MTA 16
81	51	Q	MTA 17
82	52	R	MTA 18
83	53	S	MTA 19
84	54	T	MTA 20
85	55	U	MTA 21
86	56	V	MTA 22
87	57	W	MTA 23
88	58	X	MTA 24
89	59	Y	MTA 25
90	5A	Z	MTA 26
91	5B	[	MTA 27
92	5C	\	MTA 28
93	5D	]	MTA 29
94	5E	∩	MTA 30
95	5F	—	UNL

* Message sent or received with ATN true. Numbers shown are primary address resulting in MTA (My Talk Address).

Decimal	Hexadecimal	ASCII	IEEE-488 Messages*
96	60	∩	MSA 0,PPE
97	61	a	MSA 1,PPE
98	62	b	MSA 2,PPE
99	63	c	MSA 3,PPE
100	64	d	MSA 4,PPE
101	65	e	MSA 5,PPE
102	66	f	MSA 6,PPE
103	67	g	MSA 7,PPE
104	68	h	MSA 8,PPE
105	69	i	MSA 9,PPE
106	6A	j	MSA 10,PPE
107	6B	k	MSA 11,PPE
108	6C	l	MSA 12,PPE
109	6D	m	MSA 13,PPE
110	6E	n	MSA 14,PPE
111	6F	o	MSA 15,PPE
112	70	p	MSA 16,PPD
113	71	q	MSA 17,PPD
114	72	r	MSA 18,PPD
115	73	s	MSA 19,PPD
116	74	t	MSA 20,PPD
117	75	u	MSA 21,PPD
118	76	v	MSA 22,PPD
119	77	w	MSA 23,PPD
120	78	x	MSA 24,PPD
121	79	y	MSA 25,PPD
122	7A	z	MSA 26,PPD
123	7B	{	MSA 27,PPD
124	7C	|	MSA 28,PPD
125	7D	}	MSA 29,PPD
126	7E	~	MSA 30,PPD
127	7F	DEL	

* Message sent or received with ATN true. Numbers represent secondary address values resulting in MSA (My Secondary Address).

E

Controller Programs

The following programs have been supplied as a simple aid to the user and are not intended to suit specific needs. Each program allows you to send a command message to the instrument and obtain and display a response from the instrument for query commands.

Programs for the following controllers are included:

- A BASIC program for an IBM PC/XT/AT with a Capital Equipment Corporation PC<>488 Interface (Keithley Model PC-488-CEC IEEE-488 Interface Card).
- A BASIC program for an IBM PC/XT/AT with IOtech Driver488 Software.
- A BASIC program for a Hewlett-Packard Model 9000 Series 200/300 computer.
- A program written with the ASYST software package (available from Keithley Instruments) for an IBM PC/XT/AT with a Capital Equipment Corporation PC<>488 Interface.

IBM PC/XT/AT with Capital Equipment Corporation PC<>488 Interface (Keithley PC-488-CEC)

Introduction

General information about controlling a Model 7001 with an IBM PC/XT/AT computer and Capital Equipment Corporation PC<>488 interface is given here. Refer to the CEC PC<>488 Programming and Reference Manual for complete information.

Initializing the system

The first step in any program is to initialize the system using the INITIALIZE routine. This routine sets the primary IEEE-488 bus address of the PC<>488, specifies the type of controller to be used, and sends an interface clear (IFC) to the other devices on the bus.

After booting up the IBM using DOS and entering BASICA, the statements of Program 1 can be used at the start of any program to initialize the system.

Line 30 sets the address of the PC<>488 to 21, however, any other valid address could be used as long as it does not conflict with the address of any other device on the bus.

Interface basic programming statements

This paragraph covers the PC<>488 statements that are essential to Model 7001 operation. A partial list of programming statements is contained in Table E-1. The IBM BASIC CALL statement is used to execute the desired action. Before a CALL routine can be used, BASIC needs to know the offset address of the routine. In the table, the first statement of each programming sequence defines the offset address of the CALL routine.

Example program

The following program sends a command message from an IBM PC/XT/AT computer to the Model 7001 and displays the response to a query on the CRT. The computer must be equipped with a CEC interface card and DOS 2.0 (or later revision) operating system.

Directions

1. Using the front panel MENU key, set the primary IEEE-488 address of the Model 7001 (GPIB selection) to 7.

2. With the power off, connect the Model 7001 to the IEEE-488 interface card installed in the IBM computer.

3. Type in BASICA on the computer keyboard to get into interpretive BASIC language.

4. Enter the lines of Program 2 using the return key after each line.

5. Run the program and type in the desired command string at the ENTER COMMAND MESSAGE prompt. For example, to request the currently defined Scan List, type in :SCAN? and press the return key. The Scan List will appear on the computer CRT.

Table E-1
BASIC statements necessary to send bus commands

Action	PC<>488 statements
Transmit command string (CMD$) to device 7.	SEND =9 ADDRESS%=7 CALL SEND(ADDRESS%,CMD$,STATUS%)
Obtain string from device 7.	ENTER=21 ADDRESS%=7 RESPONSE$=SPACE$(50) CALL ENTER(RESPONSE$,LENGTH%,ADDRESS%,STATUS%)
Send GTL to device 7.	TRANSMIT=3 CMD$="LISTEN 7 GTL" CALL TRANSMIT(CMD$,STATUS%)
Send SDC to device 7.	TRANSMIT=3 CMD$="LISTEN 7 SDC" CALL TRANSMIT(CMD$,STATUS%)
Send DCL to all devices.	TRANSMIT=3 CMD$="LISTEN 7 DCL" CALL TRANSMIT(CMD$,STATUS%)
Send remote enable.	TRANSMIT=3 CMD$="REN LISTEN 7" CALL TRANSMIT(CMD$,STATUS%)
Serial poll device 7.	SPOLL=12 ADDRESS%=7 CALL SPOLL%(ADDRESS%,POLL%,STATUS%)

```
10 DEF SEG=&HC400                    ' Memory address.
20 INITIALIZE=0                      ' Offset address of routine.
30 MY.ADDRESS%=21                    ' Set PC<>488 address.
40 CONTROLLER%=0                     ' Set for system control.
50 CALL INITIALIZE (MY.ADDRESS%,     ' Initialize system.
   CONTROLLER%)
```

Program 1

```
10 DEF SEG=&HC400                       ' Memory address.
20 INITIALIZE=0                         ' Define call offsets.
30 SEND=9:ENTER=21
40 MY.ADDRESS%=21                       ' Set PC<>488 address.
50 INST.ADDRESS%=7                      ' Set 7001 address.
60 CONTROLLER%=0                        ' Set for system control.
70 CALL INITIALIZE (MY.ADDRESS%,        ' Initialize system.
   CONTROLLER%)
80 LINE INPUT "ENTER COMMAND            ' Prompt for command message.
   MESSAGE   ";CMD$
90 CALL SEND (INST.ADDRESS%,CMD$,       ' Send command message.
   STATUS%)
100  IF RIGHT$(CMD$, 1) <> "?"          ' Test for query. If command is a
     THEN GOTO 80                         query, goto 80.
110 RESPONSE$=SPACE$(80)                ' Make room for data.
120 CALL ENTER (RESPONSE$,LENGTH%,      ' Get response to query from 7001.
    INST.ADDRESS%,STATUS%)
130 PRINT RESPONSE$                     ' Display response to query.
140 GOTO 80                             ' Repeat.
150 END
```

Program 2

IBM PC/XT/AT or PS/2 with IOtech Driver488 Software

Introduction

Driver488 software is an IEEE-488 driver for IBM PC and compatible computers. When combined with an IEEE-488 interface board, the package can control devices from languages including BASIC, Pascal, Fortran, and C. Driver488 software is compatible with:

- IOtech GP488B or GP488/2 boards
- National Instruments GPIB-PC, PCII, PCIIA, or PCIII boards
- Capital Equipment #01000-00300 board
- IBM GPIB Adapter

The following GW-BASIC program sends a command message to the Model 7001 and displays the instrument response for queries on the CRT. The computer must be equipped with an IEEE-488 interface board, the DOS 3.00 (or later) operating system, and a language with DOS I/O capability. Driver488 controller software must be installed and configured as described in the instruction manual.

Directions

1. Using the front panel MENU key and the GPIB menu item, set the primary address of the Model 7001 to 7.
2. With power off, connect the Model 7001 to the IEEE-488 interface installed in the IBM computer.
3. Type in GWBASIC on the computer and get into the Microsoft interpretive BASIC language.
4. Enter the lines below using the return key after each line.
5. Run the program and type in the desired command string at the ENTER COMMAND MESSAGE prompt. For example, to request the currently defined Scan List, type in :SCAN? and press the return key. The Scan List will appear on the computer CRT.

```
10  OPEN "\DEV\IEEEOUT" FOR OUTPUT AS #1      ' Open file for output.
20  IOCTL#1,"BREAK"                           ' Reset.
30  PRINT#1,"RESET"
40  OPEN "\DEV\IEEEIN" FOR INPUT AS #2        ' Open file for input.
50  PRINT#1,"FILL ERROR"                      ' Enable SEQUENCE error detect.
60  LINE INPUT "ENTER COMMAND MESSAGE  ";A$   ' Prompt for and get commands.
70  IF LEN(A$)=0 THEN 140                     ' Check for null.
80  PRINT #1,"OUTPUT 07;"+A$                  ' Send commands.
90  IF RIGHT$(A$, 1) <> "?" THEN GOTO 60      ' Check for query.
100  PRINT #1,"ENTER 07"                      ' Adress 7001 to talk.
110 LINE INPUT#2,B$                           ' Get response.
120 PRINT B$                                  ' Display response message.
130 GOTO 60                                   ' Repeat.
140 END
```

Hewlett-Packard Model 9000 Series 200/300

Introduction

The following program sends a command message to the Model 7001 from a Hewlett-Packard Model 9000 Series 200/300 computer and displays the response to queries on the computer CRT. The computer must be equipped with HP BASIC 4.0.

Directions

1. Using the front panel MENU key and the GPIB menu item, set the primary IEEE-488 address of the Model 7001 to 7.
2. With the power off, connect the Model 7001 to the IEEE-488 interface card installed in the HP computer.
3. Enter the lines in the program below, using the ENTER/RETURN key after each line.
4. Press the RUN key and type in the desired command string at the ENTER COMMAND MESSAGE prompt. For example, to request the currently defined Scan List, type in :SCAN? and press the return key. The Scan List will appear on the computer CRT.

```
10  DIM A$[50], B$[50]
20  REMOTE 707                              ! Place 7001 in remote.
30  LINPUT "ENTER COMMAND MESSAGE ", A$     ! Prompt for command.
40  OUTPUT 707; A$                          ! Address 7001 to listen; send command.
50  L=LEN(A$)
60  IF A$[L,L] <> "?" THEN GOTO 30          ! If command is not a query, goto 30.
70  ENTER 707; B$                           ! If query, address 7001 to talk.
80  PRINT B$                                ! Display response to query command.
90  GOTO 30                                 ! Repeat
100 END
```

IBM PC/XT/AT or Compatible with CEC PC<>488 Interface and ASYST Software

Introduction

ASYST contains analysis, graphing, and data acquisition software in three integrated modules. Minimum requirements for ASYST include:

- IBM PC/XT/AT or 100% compatible (including PS/2, 386 or 486-based computers in real mode)
- DOS 2.0 (DOS 3.0 or above recommended)
- Intel 8087, 80287, or 80387 math coprocessor
- 640K RAM
- 25-pin parallel port
- Hard disk and one floppy
- IBM CGA, EGA, VGA, or 100% compatible; Hercules monochrome graphics
- LIM (Lotus/Intel/Microsoft) expanded memory is recommended

For this example, an optional software module is required for IEEE-488 interfacing. The computer must also be equipped with a CEC interface card (PC<>488 Model 300 or 310, or 4 × 488).

The ASYST program listed here sends a command string from an IBM computer to the Model 7001 and displays the response for queries on the computer's CRT.

Directions

1. Using the front panel menu, set the primary address of the Model 7001 to 07.

2. With the power off, connect the Model 7001 to the IEEE-488 interface card installed in the IBM computer.

3. Boot ASYST software. Enter the Main Configuration Menu: use the <F2> key from the OK prompt, or select CONFIG from the menu bar.

4. In addition to the usual configuration requirements of ASYST, the GPIB must be configured. From the Overlay Configuration menu, select GPIB from the Available Overlays list; then select GPIB Master and Type 1 NEC GPIB driver from the pop-up menu.

5. From the GPIB Configuration menu, select a bus number, the board number for a Capital Equipment PC<>488 (NEC uPD7210 type), a primary address (0), the hexadecimal I/O address (2B8, also known as the memory address), and an unused interrupt line.

6. Save your changes and return to the OK prompt or the menu bar.

7. Use the command line editor to enter the example program. From the OK prompt, type EDIT 7001.DMO; from the menu bar, select EDIT and type 7001.DMO. Save the program and exit the editor.

8. When prompted, load the program with the L key, or type LOAD 7001.DMO from the OK prompt.

9. When the program loads properly, type MAIN from the OK prompt to start execution.

10. Type in the desired command string at the "Enter command string:" prompt. For example, to close multiplexer channels, type in :CLOS (@1!1:1!5) and press the return key. The Model 7001 will show closed channels on card 1. To query for closed channels, type in :CLOS:STAT? and press the return key. The Model 7001 closed channel list will then appear on the computer display.

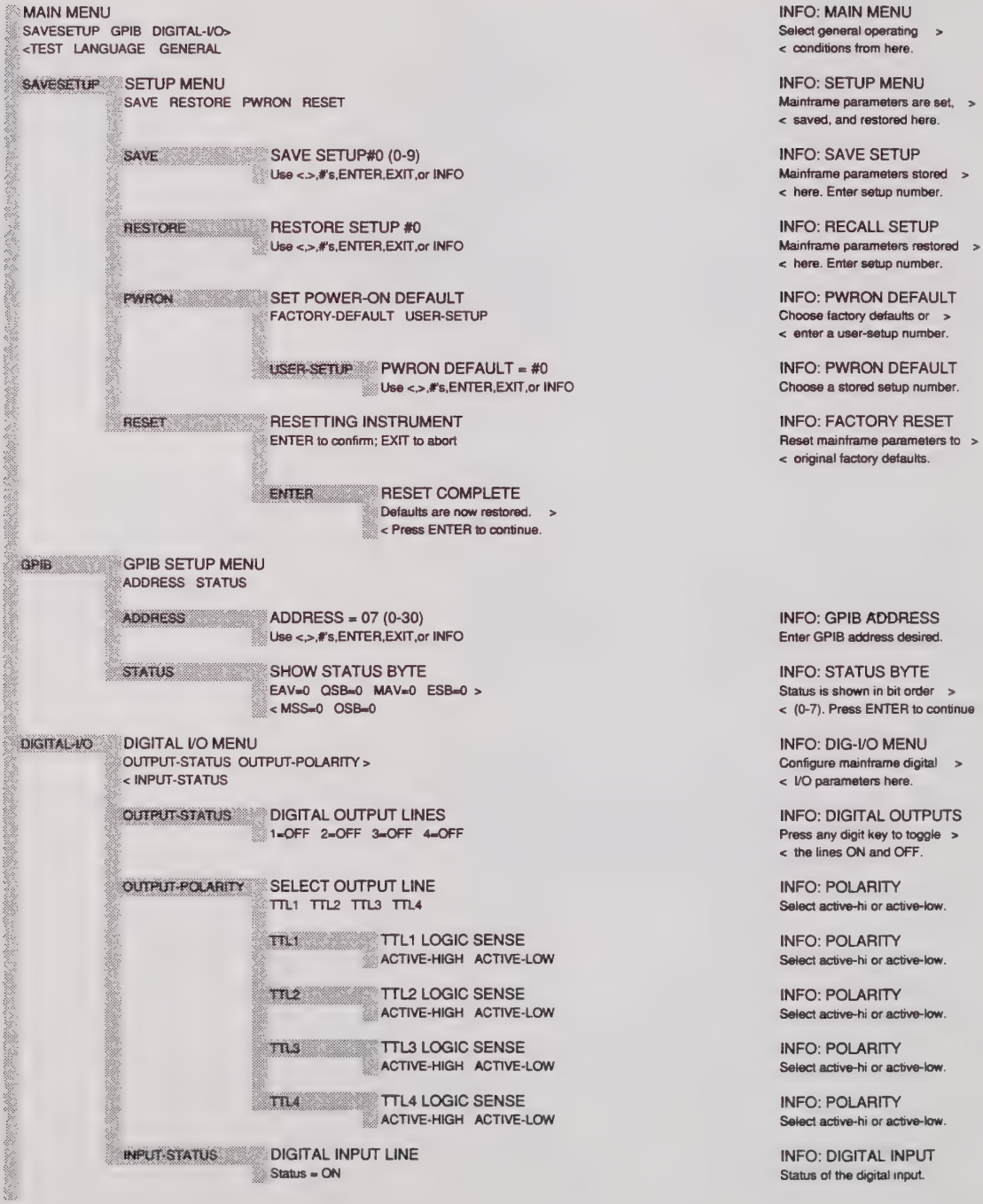
11. Type <Control-Break> to exit the program loop of 7001.DMO and return to the OK prompt. The program-defined words can be removed from the ASYST dictionary by typing FORGET 7001.

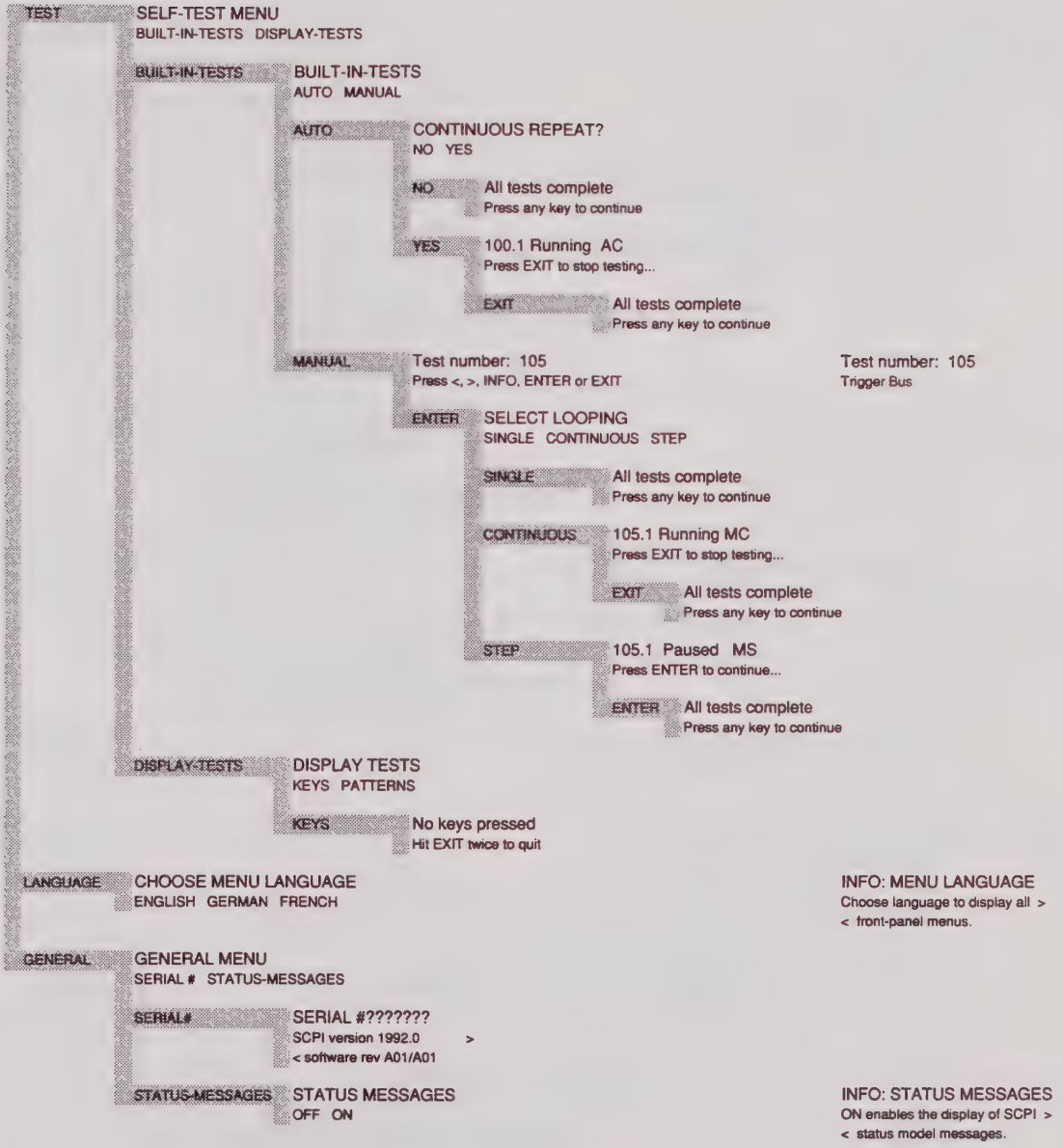
```
BUS.INIT                          \ Initialize bus
SEND.INTERFACE.CLEAR              \ Take control of bus
REMOTE.ENABLE.ON                  \ Allow remote operation
SYNCHRONOUS.GPIB                  \ Make sure ASYST is in sync. mode
?GPIB.DEVICES                     \ List controller parameters
07 GPIB.DEVICE 7001               \ Set 7001 address and name
    EOI.ON                        \ Enable end or identify
    EOS.ON                        \ Enable end of string terminator
    10 EOS.CHARACTER              \ Use LF terminator
    1000 TIMEOUT                  \ Set timeout for 1sec
?GPIB.DEVICE                      \ List 7001 parameters
100 STRING COMMAND                \ Allocate 100 bytes for user input
100 STRING RESPONSE               \ Allocate 100 bytes for 7001 response

: GET.OUTPUT                      \ Definition for 7001 output
  RESPONSE GPIB.READ              \ Get response
  CR RESPONSE "TYPE               \ Display response
;

: GET.INPUT                       \ Definition for user input
  CR ." Enter command string: "   \ Prompt user
  "INPUT COMMAND ":=              \ Get commands
  " ?" COMMAND "WITHIN            \ Test for query
  IF 7001                         \ If query, make 7001 current device
     COMMAND GPIB.WRITE           \ Send commands to 7001
     GET.OUTPUT                   \ Get response from 7001
  ELSE 7001                       \ If not query, make 7001 current device
     COMMAND GPIB.WRITE           \ Send commands to 7001
  THEN
;

: MAIN                            \ Definition for main program
  BEGIN                           \ Start loop
  ME                              \ Make controller current device
  GET.INPUT                       \ Get commands from user
  AGAIN                           \ Return for more commands
;                                 \ <Control-Break> to exit
```

F

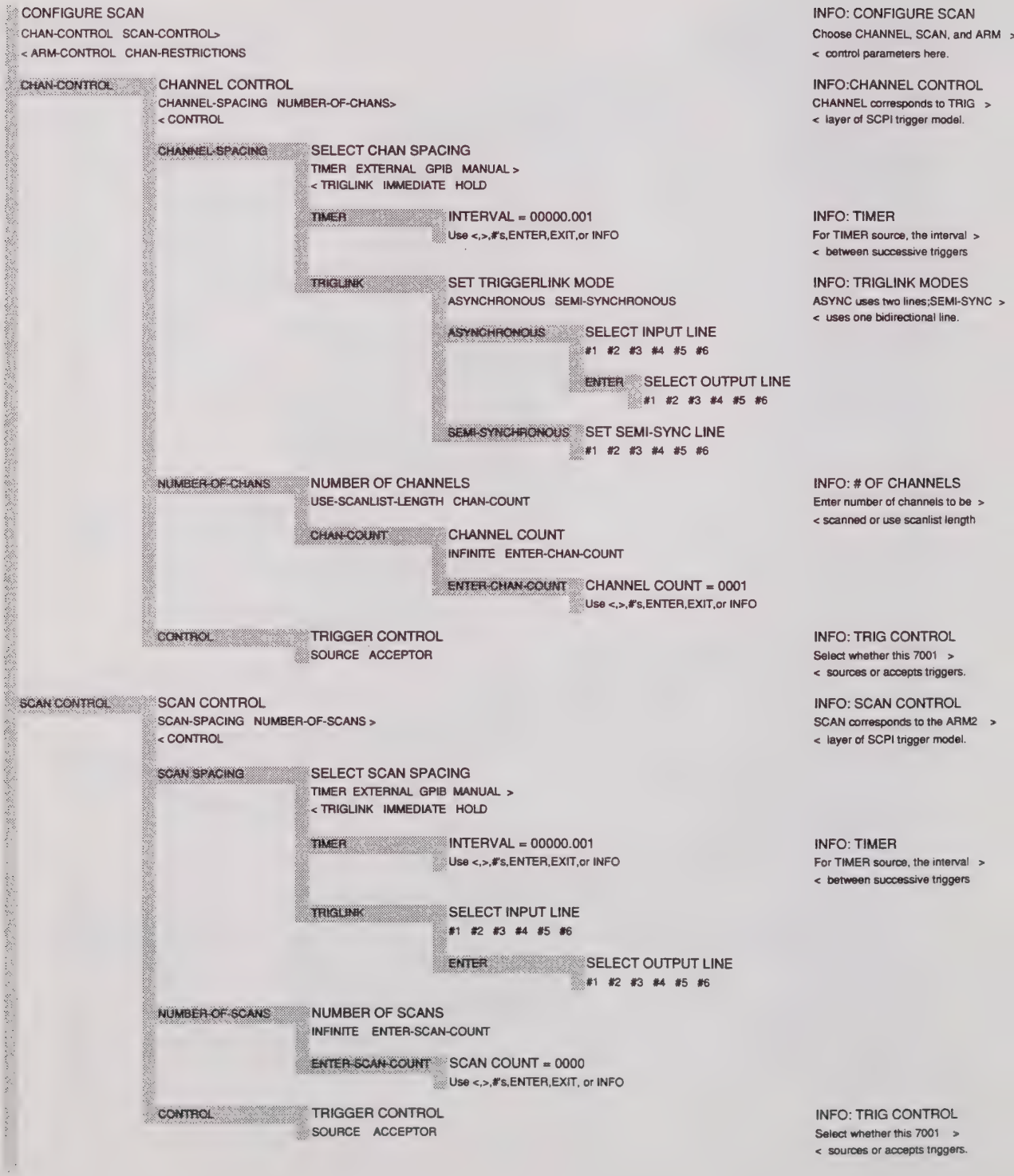
Menu Structure

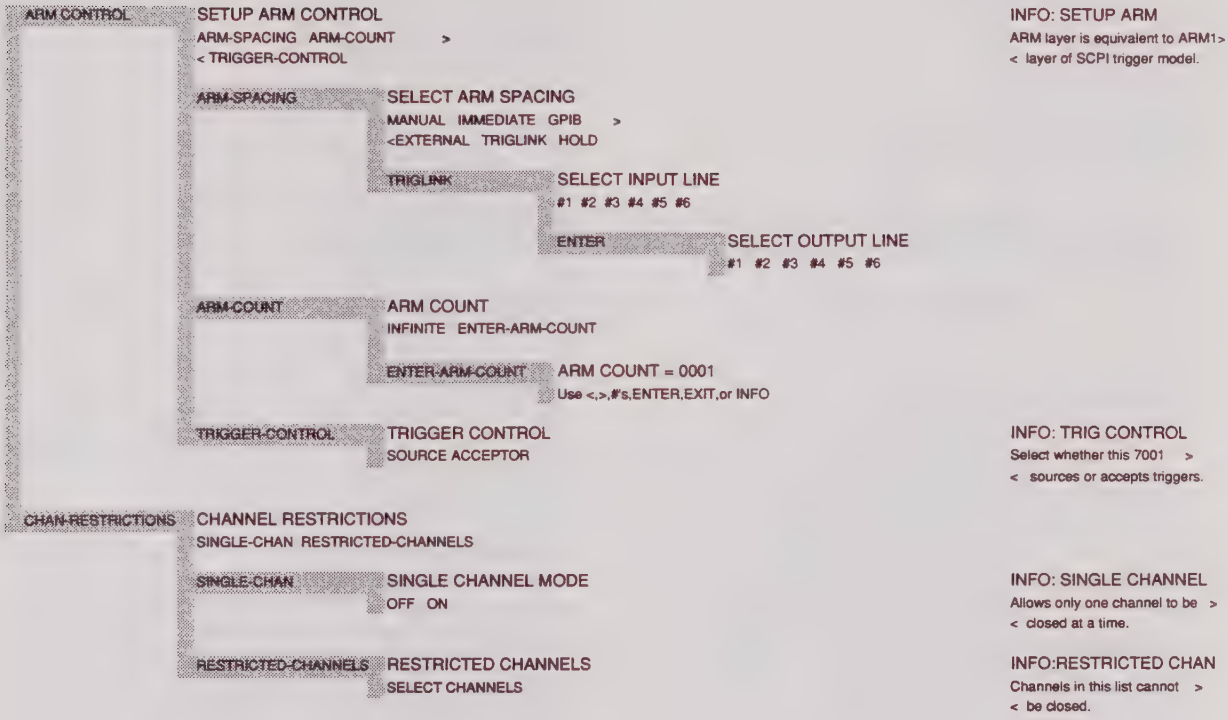
MENU


MAIN MENU
SAVESETUP GPIB DIGITAL-I/O>
<TEST LANGUAGE GENERAL
INFO: MAIN MENU
Select general operating >
< conditions from here.
SAVESETUP
SETUP MENU
SAVE RESTORE PWRON RESET
INFO: SETUP MENU
Mainframe parameters are set, >
< saved, and restored here.
SAVE
SAVE SETUP#0 (0-9)
Use <,>,#'s,ENTER,EXIT,or INFO
INFO: SAVE SETUP
Mainframe parameters stored >
< here. Enter setup number.
RESTORE
RESTORE SETUP #0
Use <,>,#'s,ENTER,EXIT,or INFO
INFO: RECALL SETUP
Mainframe parameters restored >
< here. Enter setup number.
PWRON
SET POWER-ON DEFAULT
FACTORY-DEFAULT USER-SETUP
INFO: PWRON DEFAULT
Choose factory defaults or >
< enter a user-setup number.
USER-SETUP
PWRON DEFAULT = #0
Use <,>,#'s,ENTER,EXIT,or INFO
INFO: PWRON DEFAULT
Choose a stored setup number.
RESET
RESETTING INSTRUMENT
ENTER to confirm; EXIT to abort
INFO: FACTORY RESET
Reset mainframe parameters to >
< original factory defaults.
ENTER
RESET COMPLETE
Defaults are now restored. >
< Press ENTER to continue.
GPIB
GPIB SETUP MENU
ADDRESS STATUS
ADDRESS
ADDRESS = 07 (0-30)
Use <,>,#'s,ENTER,EXIT,or INFO
INFO: GPIB ADDRESS
Enter GPIB address desired.
STATUS
SHOW STATUS BYTE
EAV=0 QSB=0 MAV=0 ESB=0 >
< MSS=0 OSB=0
INFO: STATUS BYTE
Status is shown in bit order >
< (0-7). Press ENTER to continue
DIGITAL-I/O
DIGITAL I/O MENU
OUTPUT-STATUS OUTPUT-POLARITY >
< INPUT-STATUS
INFO: DIG-I/O MENU
Configure mainframe digital >
< I/O parameters here.
OUTPUT-STATUS
DIGITAL OUTPUT LINES
1=OFF 2=OFF 3=OFF 4=OFF
INFO: DIGITAL OUTPUTS
Press any digit key to toggle >
< the lines ON and OFF.
OUTPUT-POLARITY
SELECT OUTPUT LINE
TTL1 TTL2 TTL3 TTL4
INFO: POLARITY
Select active-hi or active-low.
TTL1
TTL1 LOGIC SENSE
ACTIVE-HIGH ACTIVE-LOW
INFO: POLARITY
Select active-hi or active-low.
TTL2
TTL2 LOGIC SENSE
ACTIVE-HIGH ACTIVE-LOW
INFO: POLARITY
Select active-hi or active-low.
TTL3
TTL3 LOGIC SENSE
ACTIVE-HIGH ACTIVE-LOW
INFO: POLARITY
Select active-hi or active-low.
TTL4
TTL4 LOGIC SENSE
ACTIVE-HIGH ACTIVE-LOW
INFO: POLARITY
Select active-hi or active-low.
INPUT-STATUS
DIGITAL INPUT LINE
Status = ON
INFO: DIGITAL INPUT
Status of the digital input.

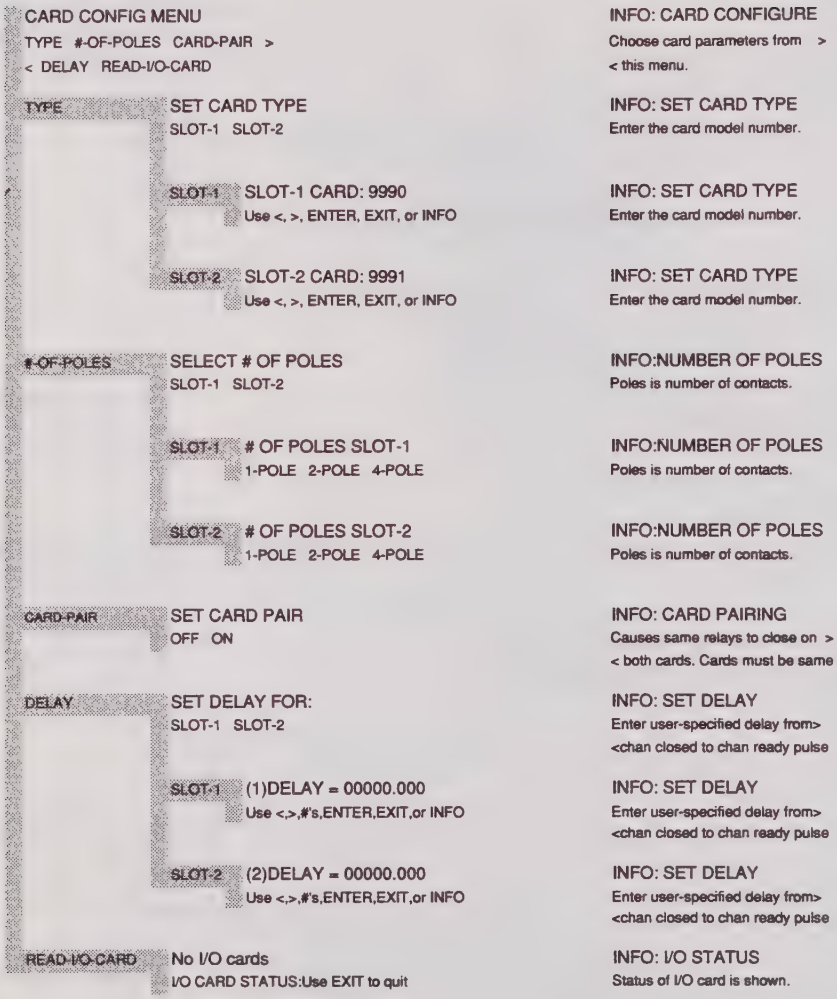

TEST
SELF-TEST MENU
BUILT-IN-TESTS DISPLAY-TESTS
BUILT-IN-TESTS
BUILT-IN-TESTS
AUTO MANUAL
AUTO
CONTINUOUS REPEAT?
NO YES
NO
All tests complete
Press any key to continue
YES
100.1 Running AC
Press EXIT to stop testing...
EXIT
All tests complete
Press any key to continue
MANUAL
Test number: 105
Press <, >, INFO, ENTER or EXIT
Test number: 105
Trigger Bus
ENTER
SELECT LOOPING
SINGLE CONTINUOUS STEP
SINGLE
All tests complete
Press any key to continue
CONTINUOUS
105.1 Running MC
Press EXIT to stop testing...
EXIT
All tests complete
Press any key to continue
STEP
105.1 Paused MS
Press ENTER to continue...
ENTER
All tests complete
Press any key to continue
DISPLAY-TESTS
DISPLAY TESTS
KEYS PATTERNS
KEYS
No keys pressed
Hit EXIT twice to quit
LANGUAGE
CHOOSE MENU LANGUAGE
ENGLISH GERMAN FRENCH
INFO: MENU LANGUAGE
Choose language to display all >
< front-panel menus.
GENERAL
GENERAL MENU
SERIAL # STATUS-MESSAGES
SERIAL#
SERIAL #???????
SCPI version 1992.0 >
< software rev A01/A01
STATUS-MESSAGES
STATUS MESSAGES
OFF ON
INFO: STATUS MESSAGES
ON enables the display of SCPI >
< status model messages.

SCAN CONFIGURATION




ARM CONTROL
SETUP ARM CONTROL
ARM-SPACING ARM-COUNT >
< TRIGGER-CONTROL
ARM-SPACING
SELECT ARM SPACING
MANUAL IMMEDIATE GPIB >
<EXTERNAL TRIGLINK HOLD
TRIGLINK
SELECT INPUT LINE
#1 #2 #3 #4 #5 #6
ENTER
SELECT OUTPUT LINE
#1 #2 #3 #4 #5 #6
ARM-COUNT
ARM COUNT
INFINITE ENTER-ARM-COUNT
ENTER-ARM-COUNT
ARM COUNT = 0001
Use <,>,#'s,ENTER,EXIT,or INFO
TRIGGER-CONTROL
TRIGGER CONTROL
SOURCE ACCEPTOR
INFO: SETUP ARM
ARM layer is equivalent to ARM1>
< layer of SCPI trigger model.
INFO: TRIG CONTROL
Select whether this 7001 >
< sources or accepts triggers.
CHAN-RESTRICTIONS
CHANNEL RESTRICTIONS
SINGLE-CHAN RESTRICTED-CHANNELS
SINGLE-CHAN
SINGLE CHANNEL MODE
OFF ON
INFO: SINGLE CHANNEL
Allows only one channel to be >
< closed at a time.
RESTRICTED-CHANNELS
RESTRICTED CHANNELS
SELECT CHANNELS
INFO:RESTRICTED CHAN
Channels in this list cannot >
< be closed.

CARD CONFIGURATION



G

IEEE-488 Bus Overview

Introduction

Basically, the IEEE-488 bus is simply a communication system between two or more electronic devices. A device can be either an instrument or a computer. When a computer is used on the bus, it serves to supervise the communication exchange between all the devices and is known as the controller. Supervision by the controller consists of determining which device will talk and which device will listen. As a talker, a device will output information and as a listener, a device will receive information. To simplify the task of keeping track of the devices, a unique address number is assigned to each one.

On the bus, only one device can talk at a time and is addressed to talk by the controller. The device that is talking is known as the active talker. The devices that need to listen to the talker are addressed to listen by the controller. Each listener is then referred to as an active listener. Devices that do not need to listen are instructed to unlisten. The reason for the unlisten instruction is to optimize the speed of bus information transfer since the task of listening takes up bus time.

Through the use of control lines, a handshake sequence takes place in the transfer process of information from a talker to a listener. This handshake sequence helps ensure the credibility of the information transfer. The basic handshake sequence between an active controller (talker) and a listener is as follows:

1. The listener indicates that it is ready to listen.
2. The talker places the byte of data on the bus and indicates that the data is available to the listener.
3. The listener, aware that the data is available, accepts the data and then indicates that the data has been accepted.
4. The talker, aware that the data has been accepted, stops sending data and indicates that data is not being sent.
5. The listener, aware that there is no data on the bus, indicates that it is ready for the next byte of data.

Bus Description

The IEEE-488 bus, which is also frequently referred to a the GPIB (General Purpose Interface Bus), was designed as a parallel transfer medium to optimize data transfer without using an excessive number of bus lines. In keeping with this goal, the bus has only eight data lines that are used for both data and with most commands. Five bus management lines and three handshake lines round out the complement of bus signal lines

A typical set up for controlled operation is shown in Figure G-1. Generally, a system will contain one controller and a number of other instruments to which the commands are given. Device operation is categorized into three operators: controller, talker and listener. The controller does what its name implies; it controls the instruments on the bus. The talker sends data while a listener receives data. Depending on the type of instrument, any particular device can be a talker only, a listener only or both a talker and listener.

There are two categories of controllers: system controller, and basic controller. Both are able to control other instruments, but only the system controller has the absolute authority in the system. In a system with more than one controller, only one controller may be active at any given time. Certain protocol is used to pass control from one controller to another.

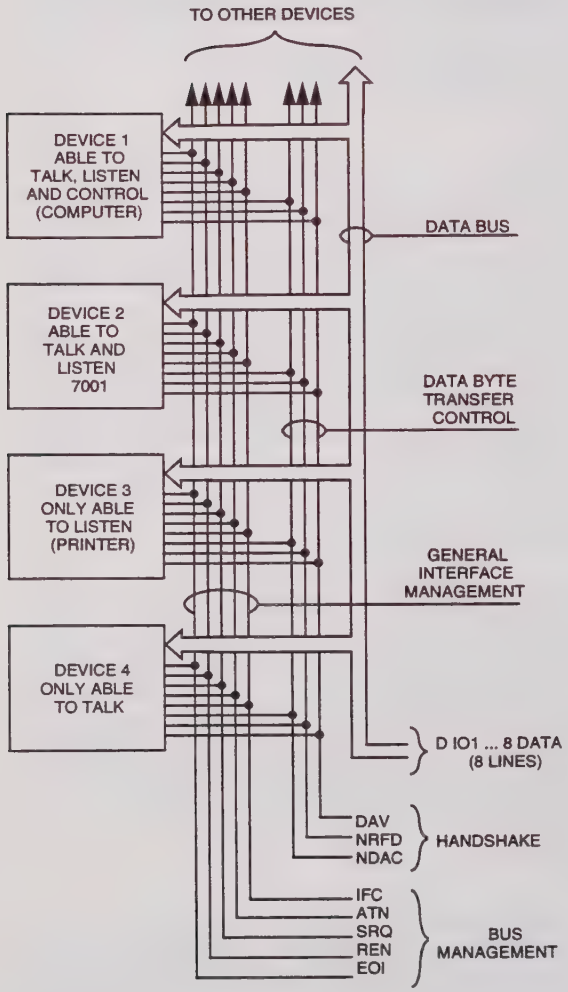


Figure G-1
IEEE-488 bus configuration

The IEEE-488 bus is limited to 15 devices, including the controller. Thus, any number of talkers and listeners up to that limit may be present on the bus at one time. Although several devices may be commanded to listen simultaneously, the bus can have only one active talker, or communications would be scrambled.

A device is placed in the talk or listen state by sending an appropriate talk or listen command. These talk and listen commands are derived from an instrument's primary address. The primary address may have any value between 0 and 31, and is generally set by rear panel DIP switches or programmed in from the front panel of the instrument. The actual listen address value sent out over the bus is obtained by ORing the primary address with $20. For example, if the primary address is 27 decimal ($07), the actual listen address is $27 ($27 = $07 + $20). In a similar manner, the talk address is obtained by ORing the primary address with $40. With the present example, the talk address derived from a primary address of 7 decimal would be $47 ($47 = $07 + $40).

The IEEE-488 standards also include another addressing mode called secondary addressing. Secondary addresses lie in the range of $60-$7F. Note, however, that many devices, including the Model 7001, do not use secondary addressing.

Once a device is addressed to talk or listen, the appropriate bus transactions take place. For example: if the instrument is addressed to talk, it places its data string on the bus one byte at a time. The controller reads the information and the appropriate software can be used to direct the information to the desired location.

Bus Lines

The signal lines on the IEEE-488 bus are grouped into three different categories: data lines, management lines and handshake lines. The data lines handle bus data and commands, while the management and handshake lines ensure that proper data transfer and operation takes place. Each bus line is active low, with approximately zero volts representing a logic 1 (true). The following paragraphs describe the operation of these lines.

Data lines

The IEEE-488 bus uses eight data lines that transfer data one byte at a time. DIO1 (Data Input/Output) through DIO8 (Data Input/Output) are the eight data lines used to transmit both data and multiline commands and are bidirectional. The data lines operate with low true logic.

Bus management lines

The five bus management lines help to ensure proper interface control and management. These lines are used to send the uniline commands.

ATN (Attention) — The ATN line is one of the more important management lines in that the state of this line determines how information on the data bus is to be interpreted.

IFC (Interface Clear) — As the name implies, the IFC line controls clearing of instruments from the bus.

REN (Remote Enable) —The REN line is used to place the instrument on the bus in the remote mode.

EOI (End or Identify) — The EOI is usually used to mark the end of a multi-byte data transfer sequence.

SRQ (Service Request) — This line is used by devices when they require service from the controller.

Handshake lines

The bus handshake lines operate in an interlocked sequence. This method ensures reliable data transmission regardless of the transfer rate. Generally, data transfer will occur at a rate determined by the slowest active device on the bus.

One of the three handshake lines is controlled by the source (the talker sending information), while the remaining two lines are controlled by accepting devices (the listener or listeners receiving the information). The three handshake lines are:

DAV (DATA VALID) — The source controls the state of the DAV line to indicate to any listening devices whether or not data bus information is valid.

NRFD (Not Ready For Data) — The acceptor controls the state of NRFD. It is used to signal to the transmitting device to hold off the byte transfer sequence until the accepting device is ready.

NDAC (Not Data Accepted) — NDAC is also controlled by the accepting device. The state of NDAC tells the source whether or not the device has accepted the data byte.

The complete handshake sequence for one data byte is shown in Figure G-2. Once data is placed on the data lines, the source checks to see that NRFD is high, indicating that all active devices are ready. At the same time, NDAC should be low from the previous byte transfer. If these conditions are not met, the source must wait until NDAC and NRFD have the correct status. If the source is a controller, NRFD and NDAC must be stable for at least 100nsec after ATN is set true. Because of the possibility of a bus hang up, many controllers have time-out routines that display messages in case the transfer sequence stops for any reason.

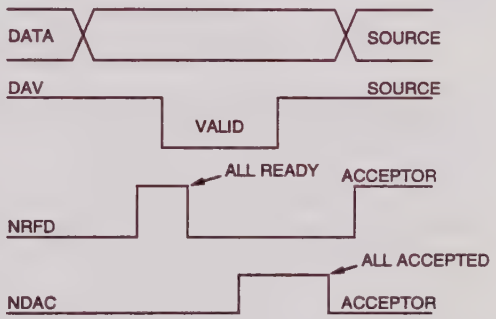


Figure G-2
IEEE-488 handshake sequence

Once all NDAC and NRFD are properly set, the source sets DAV low, indicating to accepting devices that the byte on the data lines is now valid. NRFD will then go low, and NDAC will go high once all devices have accepted the data. Each device will release NDAC at its own rate, but NDAC will not be released to go high until all devices have accepted the data byte.

The sequence just described is used to transfer both data, talk and listen addresses, as well as multiline commands. The state of the ATN line determines whether the data bus contains data, addresses or commands as described in the following paragraph.

Bus Commands

The instrument may be given a number of special bus commands through the IEEE-488 interface. This section briefly describes the purpose of the bus commands which are grouped into the following three categories.

1. Uniline Commands — Sent by setting the associated bus lines true. For example, to assert REN (Remote Enable), the REN line would be set low (true).
2. Multiline Commands — General bus commands which are sent over the data lines with the ATN line true (low).
3. Common Commands — Commands that are common to all devices on the bus; sent with ATN high (false).
4. SCPI Commands — Commands that are particular to each device on the bus; sent with ATN (false).

These bus commands and their general purpose are summarized in Table G-1.

Uniline commands

ATN, IFC and REN are asserted only by the controller. SRQ is asserted by an external device. EOI may be asserted either by the controller or other devices depending on the direction of data transfer. The following is a description of each command. Each command is sent by setting the corresponding bus line true.

REN (Remote Enable) — REN is sent to set up instruments on the bus for remote operation. When REN is true, devices will be removed from the local mode. Depending on device configuration, all front panel controls except the LOCAL button (if the device is so equipped) may be locked out when REN is true. Generally, REN should be sent before attempting to program instruments over the bus.

EOI (End or Identify) — EOI is used to positively identify the last byte in a multi-byte transfer sequence, thus allowing data words of various lengths to be transmitted easily.

IFC (Interface Clear) — IFC is used to clear the interface and return all devices to the talker and listener idle states.

ATN (Attention) — The controller sends ATN while transmitting addresses or multiline commands.

SRQ (Service Request) — SRQ is asserted by a device when it requires service from a controller.

Table G-1
IEEE-488 bus command summary

Command type	Command	State of ATN line	Comments
Uniline	REN (Remote Enable)	X	Set up devices for remote operation.
	EOI	X	Marks end of transmission.
	IFC (Interface Clear)	X	Clears interface.
	ATN (Attention)	Low	Defines data bus contents.
	SRQ	X	Controlled by external device.
Multiline Universal	LLO (Local Lockout)	Low	Locks our local operation.
	DCL (Device Clear)	Low	Returns device to default conditions.
	SPE (Serial Enable)	Low	Enables serial polling.
	SPD (Serial Poll Disable)	Low	Disables serial polling.
Addressed	SDC (Selective Device Clear)	Low	Returns unit to default conditions.
	GTL (Go To Local)	Low	Returns device to local.
Unaddressed	UNL (Unlisten)	Low	Removes all listeners from the bus.
	UNT (Untalk)	Low	Removes any talkers from the bus.
Common	—	High	Programs IEEE-488.2 compatible instruments for common operations.
SCPI	—	High	Programs SCPI compatible instruments for particular operations.

Universal multiline commands

Universal commands are those multiline commands that require no addressing. All devices equipped to implement such commands will do so simultaneously when the commands are transmitted. As with all multiline commands, these commands are transmitted with ATN true.

LLO (Local Lockout) — LLO is sent to the instrument to lock out the LOCAL key and thus all their front panel controls.

DCL (Device Clear) — DCL is used to return instruments to some default state. Usually, instruments return to their power-up conditions.

SPE (Serial Poll Enable) — SPE is the first step in the serial polling sequence which is used to determine which device has requested service.

SPD (Serial Poll Disable) — SPD is used by the controller to remove all devices on the bus from the serial poll mode and is generally the last command in the serial polling sequence.

Addressed multiline commands

Addressed commands are multiline commands that must be preceded by the device listen address before that instrument will respond to the command in question. Note that only the addressed device will respond to these commands. Both the commands and the address preceding it are sent with ATN true.

SDC (Selective Device Clear) — The SDC command performs essentially the same function as the DCL command except that only the addressed device responds. Generally, instruments return to their power-up default conditions when responding to the SDC command.

GTL (Go To Local) — The GTL command is used to remove instruments from the remote mode. With some instruments, GTL also unlocks front panel controls if they were previously locked out with the LLO command.

GET (Group Execute Trigger) — The GET command is used to trigger devices to perform a specific action that depends on device configuration (for example, take a reading). Although GET is an addressed command, many devices respond to GET without addressing.

Address commands

Addressed commands include two primary command groups and a secondary address group. ATN is true when these commands are asserted. The commands include:

LAG (Listen Address Group) — These listen commands are derived from an instrument's primary address and are used to address devices to listen. The actual command byte is obtained by ORing the primary address with $20.

TAG (Talk Address Group) — The talk commands are derived from the primary address by ORing the address with $40. Talk commands are used to address devices to talk.

SCG (Secondary Command Group) — Commands in this group provide additional addressing capabilities. Many devices (including the Model 7001) do not use these commands.

Unaddress commands

The two unaddress commands are used by the controller to remove any talkers or listeners from the bus. ATN is true when these commands are asserted.

UNL (Unlisten) — Listeners are placed in the listener idle state by the UNL command.

UNT (Untalk) — Any previously commanded talkers will be placed in the talker idle state by the UNT command.

Common commands

Common commands are commands that are common to all devices on the bus. These commands are designated and defined by the IEEE-488.2 standard.

Generally, these commands are sent as one or more ASCII characters that tell the device to perform a common operation, such as reset. The IEEE-488 bus treats these commands as data in that ATN is false when the commands are transmitted.

SCPI commands

SCPI commands are commands that are particular to each device on the bus. These commands are designated by the instrument manufacturer, and are based on the instrument model defined by the Standard Commands for Programmable Instruments (SCPI) Consortium's SCPI standard.

Generally, these commands are sent as one or more ASCII characters that tell the device to perform a particular operation, such as setting a range or closing a relay. The IEEE-488 bus treats these commands as data in that ATN is false when the commands are transmitted.

Command codes

Command codes for the various commands that use the data lines are summarized in Figure G-3. Hexadecimal and the decimal values for the various commands are listed in Table G-2.

D_7 D_6 D_5 D_4					X 0 0 0	X 0 0 0	X 0 0 1	X 0 1 0	X 0 1 1	X 1 0 0	X 1 0 1	X 1 1 0	X 1 1 1	
Bits	D_3 ↓	D_2 ↓	D_1 ↓	D_0 ↓	COLUMN → ROW ↓	0(A)	0(B)	1(A)	1(B)	2(A)	2(B)	3(A)	3(B)	4(A)	4(B)	5(A)	5(B)	6(A)	6(B)	7(A)	7(B)
	0	0	0	0	0	NUL		DLE		SP	0	0	16	@	0	P	16			p	
	0	0	0	1	1	SOH	GTL	DC1	LLO	!	1	1	17	A	1	Q	17	a		q	
	0	0	1	0	2	STX		DC2		"	2	2	18	B	2	R	18	b		r	
	0	0	1	1	3	ETX		DC3		#	3	3	19	C	3	S	19	c		s	
	0	1	0	0	4	EOT	SDC	DC4	DCL	$	4	4	20	D	4	T	20	d		t	
	0	1	0	1	5	ENQ	PPC*	NAK	PPU*	%	5	5	21	E	5	U	21	e		u	
	0	1	1	0	6	ACK		SYN		&	6	6	22	F	6	V	22	f		v	
	0	1	1	1	7	BEL		ETB		'	7	7	23	G	7	W	23	g		w	
	1	0	0	0	8	BS	GET	CAN	SPE	(	8	8	24	H	8	X	24	h		x	
	1	0	0	1	9	HT	TCT*	EM	SPD	)	9	9	25	I	9	Y	25	i		y	
	1	0	1	0	10	LF		SUB		*	10	:	26	J	10	Z	26	j		z	
	1	0	1	1	11	VT		ESC		+	11	;	27	K	11	[	27	k		{	
	1	1	0	0	12	FF		FS		,	12	<	28	L	12	\	28	l		|	
	1	1	0	1	13	CR		GS		–	13	=	29	M	13	]	29	m		}	
	1	1	1	0	14	SO		RS		.	14	>	30	N	14	^	30	n		~	
	1	1	1	1	15	SI		US		/	15	?	UNL	O	15	_	UNT	o		DEL	

ADDRESSED COMMAND GROUP (ACG)

UNIVERSAL COMMAND GROUP (UCG)

LISTEN ADDRESS GROUP (LAG)

TALK ADDRESS GROUP (TAG)

PRIMARY COMMAND GROUP (PCG)

SECONDARY COMMAND GROUP (SDC)

*PPC (PARALLEL POLL CONFIGURE), PPU (PARALLEL POLL UNCONFIGURE), AND TCT (TAKE CONTROL) NOT IMPLEMENTED BY MODEL 7001.

NOTE: D_0 = DIO1 . . . D_7 = DIO8
X = DON'T CARE

Figure G-3
Command codes

Table G-2
Hexadecimal and decimal command codes

Command	Hex value	Decimal value
GTL	01	1
SDC	04	4
GET	08	8
LLO	11	17
DCL	14	20
SPE	18	24
SPD	19	25
LAG	20-3F	32-63
TAG	40-5F	64-95
SCG	60-7F	96-127
UNL	3F	63
UNT	5F	95

Typical command sequences

For the various multiline commands, a specific bus sequence must take place to properly send the command. In particular, the correct listen address must be sent to the instrument before it will respond to addressed commands. Table G-3 lists a typical bus sequence for sending the addressed multiline commands. In this instance, the SDC command is being sent to the instrument. UNL is generally sent as part of the sequence to ensure that no other active listeners are present. Note that ATN is true for both the listen command and the SDC command byte itself

Table G-4 gives a typical common command sequence. In this instance, ATN is true while the instrument is being addressed, but it is set high while sending the common command string.

IEEE command groups

Command groups supported by the Model 7001 are listed in Table G-5. Common commands and SCPI commands are not included in this list.

Table G-3
Typical addressed command sequence

			Data bus		
Step	**Command**	**ATN state**	**ASCII**	**Hex**	**Decimal**
1	UNL	Set low	?	3F	63
2	LAG*	Stays low	0	27	39
3	SDC	Stays low	EOT	04	4
4		Returns high			

*Assumes primary address = 7.

Table G-4
Typical common command sequence

			Data bus		
Step	**Command**	**ATN state**	**ASCII**	**Hex**	**Decimal**
1	UNL	Set low	?	3F	63
2	LAG*	Stays low	0	27	39
3	Data	Set high	*	2A	42
4	Data	Stays high	R	52	82
5	Data	Stays high	S	53	83
6	Data	Stays high	T	54	84

Assumes primary address = 7.

Table G-5
IEEE command groups

HANDSHAKE COMMAND GROUP	
	NDAC = NOT DATA ACCEPTED
	NRFD = NOT READY FOR DATA
	DAV = DATA VALID
UNIVERSAL COMMAND GROUP	
	ATN = ATTENTION
	DCL = DEVICE CLEAR
	IFC = INTERFACE CLEAR
	REN = REMOTE ENABLE
	SPD = SERIAL POLL DISABLE
	SPE = SERIAL POLL ENABLE
ADDRESS COMMAND GROUP	
LISTEN	LAG = LISTEN ADDRESS GROUP
	MLA = MY LISTEN ADDRESS
	UNL = UNLISTEN
TALK	TAG = TALK ADDRESS GROUP
	MTA = MY TALK ADDRESS
	UNT = UNTALK
	OTA = OTHER TALK ADDRESS

Table G-5 (continued)
IEEE command groups

ADDRESSED COMMAND GROUP	
	ACG = ADDRESSED COMMAND GROUP
	GTL = GO TO LOCAL
	SDC = SELECTIVE DEVICE CLEAR
STATUS COMMAND GROUP	
	RQS = REQUEST SERVICE
	SRQ = SERIAL POLL REQUEST
	STB = STATUS BYTE
	EOI = END

H

IEEE-488 Conformance Information

Information

The IEEE-488.2 standard requires specific information about how the Model 7001 implements the standard. Paragraph 4.9 of the IEEE-488.2 standard (Std 488.2-1987) lists the documentation requirements. Table H-1 provides a summary of the requirements, and provides the information or references the manual for that information.

Table H-1
IEEE-488 documentation requirements

	Requirement	Description or Reference
(1)	IEEE-488 Interface Function Codes.	See Appendix C
(2)	Behavior of 7001 when the address is set outside the range 0-30.	Error message occurs. Previous address is retained.
(3)	Behavior of 7001 when valid address is entered.	No error message. Display returns to GPIB SETUP MENU.
(4)	Power-On Setup Conditions.	*RST; see paragraph 5.9.10. :SYST:PRES and :SYST:POS; see paragraph 5.10.7.
(5)	Message Exchange Options:	
(a)	Input buffer size.	256 bytes.
(b)	Queries that return more than one response message.	None.
(c)	Queries that generate a response when parsed.	All queries (Common Commands and SCPI).
(d)	Queries that generate a response when read.	None.
(e)	Coupled commands.	:TRIG:COUNT is coupled to :TRIG:COUNT:AUTO. Enabling Auto sets count to the scan list length.
(6)	Functional elements required for SCPI commands.	Contained in SCPI command subsystems tables (see Appendix B).
(7)	Buffer size limitations for block data.	Up to 20 characters for block display messages.

Table H-1
IEEE-488 documentation requirements

(8)	Syntax restrictions.	Contained in paragraph 5.10 (SCPI Command Subsystems).
(9)	Response syntax for every query command.	Contained in paragraphs 5.9 (Common Commands) and 5.10 (SCPI Command Subsystems).
(10)	Device-to-device message transfer that does not follow rules of the standard.	None.
(11)	Block data response size.	None.
(12)	Common Commands implemented by 7001.	See Appendix A
(13)	Calibration query information.	Not applicable.
(14)	Trigger macro for *DDT.	Not applicable.
(15)	Macro information.	Not applicable.
(16)	Response to *IDN (identification).	See paragraph 5.9.5.

Table H-1
IEEE-488 documentation requirements

(17)	Storage area for *PUD and *PUD?	Not applicable.
(18)	Resource description for *RDT and *RDT?	Not applicable.
(19)	Effects of *RST, *RCL and *SAV.	*RST; see paragraph 5.9.10, *RCL; see paragraph 5.9.9, *SAV; see paragraph 5.9.11.
(20)	*TST information.	See Section 7.
(21)	Status register structure.	See paragraph 5.6.
(22)	Sequential or overlapped commands.	All are sequential except :INIT and :INIT:CONT ON which are sequential.
(23)	Operation complete messages.	*OPC; see paragraph 5.9.6, *OPC?; see paragraph 5.9.7, *WAI; see paragraph 5.9.17.

I

SCPI Conformance Information

Introduction

The Model 7001 complies with SCPI version 1992.0.

Table I-1
Syntax of SCPI confirmed commands implemented by Model 7001

Command	Description
:DISPlay	
[:WINDow[1]]	Path to locate message to top portion of display
:TEXT	Path to control user text messages:
:DATA <a>	Define ASCII message "a" using up to 20 characters.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message.
:STATe?	Request message status (enabled or disabled).
:WINDow2	Path to locate message to bottom portion of display:
:TEXT	Path to control user text messages:
:DATA <a>	Define ASCII message "a" using up to 32 characters.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message.
:STATe?	Request message status (enabled or disabled).
[:ROUTe]	
:CLOSe <list>	Path and command to close specified channels:
:STATe?	Request channels that are closed.
:OPEN <list> | ALL	Open specified (or all) channels.
:SCAN <list>	Path and command to specify channel list:
:POINts?	Request number of channels in the scan list.
:STATus	
:OPERation	Path to control operation event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 to 1122).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 to 1122).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 to 1122).
:ENABle?	Read the enable register.
:ARM	Path to control arm event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 or 2).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 or 2).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 or 2).
:ENABle?	Read the enable register.

Table I-1
Syntax of SCPI confirmed commands implemented by Model 7001

Command	Description
:SEQuence	Path to control the sequence event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 to 6).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 to 6).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 to 6).
:ENABle?	Read the enable register.
:TRIGger	Path to control trigger event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register (0 or 2).
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register (0 or 2).
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register (0 or 2).
:ENABle?	Read the enable register.
:PRESet	Return status registers to default states.
:QUEue	Path to access error queue:
[:NEXT]?	Request most recent error message.
:ENABle <list>	Specify error and status messages for queue.
:QUEStionable	Path to control questionable event registers:
[:EVENt]?	Read the status register.
:CONDition?	Read the condition register.
:PTRansition <n>	Program the positive transition register.
:PTRansition?	Read the positive transition register.
:NTRansition <n>	Program the negative transition register.
:NTRansition?	Read the negative transition register.
:ENABle <n>	Program the enable register.
:ENABle?	Read the enable register.
:SYSTem	
:ERRor?	Request message from Error/Status Queue.
:PRESet	Return instrument to default conditions.
:VERSion?	Request the revision level of the SCPI Standard.

Table I-1
Syntax of SCPI confirmed commands implemented by Model 7001

Command	Description
Trigger commands	
:INITiate	Subsystem command path:
[:IMMediate]	Initiate one trigger (scan) cycle.
:CONTinuous <b>	Enable (1 or ON) or disable (0 or OFF) continuous initiation of trigger system.
:ABORt	Reset trigger system and go to idle state.
:ARM[:SEQuence[1]]	Subsystem command path to configure scan:
[:LAYer[1]]	Path to program arm layer of scan:
:IMMediate	Loop around control source.
:COUNt <n> | INFinite	Program number of arms (1 to 9999, or INFinite).
:COUNt?	Request programmed arm count.
:SOURce HOLD | IMMediate | MANual | BUS | EXTernal	Select Arm Layer 1 control source.
:SOURce?	Request programmed source (event).
:SIGNal	Loop around control source.
:LAYer2	Path to program scan layer of scan:
:IMMediate	Loop around control source.
:COUNt <n> | INFinite	Program number of scans (1 to 9999, or INFinite).
:COUNt?	Request programmed scan count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:DELay?	Request programmed delay period.
:SOURce HOLD | IMMediate | MANual | BUS | EXTernal | TIMer	Select Arm Layer 2 control source.
:SOURce?	Request programmed source (event).
:SIGNal	Bypass scan control source one time only.
:TIMer <num>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Request the programmed timer interval.
:TRIGger[:SEQuence[1]]	Path to program channel layer of scan:
:IMMediate	Scan channels immediately. (Loop around control source.)
:COUNt <n> | INFinite	Program number of channels (1 to 9999, or INFinite).
:AUTo ON/OFF	Use scan-list-length.
:COUNt?	Request programmed channel count.
:DELay <num>	Program delay (0 to 99999.999 sec)
:DELay?	Request programmed delay period.
:SOURce HOLD | IMMediate | MANual | BUS | EXTernal | TIMer	Select Trigger Layer Control Source.
:SOURce?	Request programmed source (event).
:SIGNal	Bypass channel control source one time only.
:TIMer <num>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Request the programmed timer interval.

Table I-2
Syntax of non-SCPI commands implemented by Model 7001

Command	Description
:DISPlay	
:SMESsage <b>	Enable (1 or ON) or disable (0 or OFF) displayed status messages.
:SMESsage?	Request state of status message display.
:OUTPut	
:TTLn	Path and command to specify output line "n" (1-4):
:LSENse AHIGh | ALOW	Set polarity; active high (AHIG) or active low (ALOW).
:LSENse?	Request polarity of specified output line (n).
[:ROUTe]	
:SCAN?	Request the programmed scan list.
:FCHannels <list>	Specifies channels that cannot be closed (forbidden).
:FCHannels?	Request list of restricted channels.
:CONFigure:	Configuration command path:
:SCHannel <b>	Enable (1 or ON) or disable (0 or OFF) Single Channel.
:SCHannel?	Request status of Single Channel mode.
:CPAir <b>	Enable (1 or ON) or disable (0 or OFF) Channel Pairing.
:CPAir?	Request status of Channel Pairing.
:SLOT1	Path to configure CARD 1:
:CTYPE <type>	Specify the card type installed in the slot.
:CTYPE?	Request the card type installed in the slot.
:POLE <n>	Select pole mode (1, 2 or 4).
:POLE?	Request the programmed number of poles.
:STIMe <num>	Set relay settling time in seconds (0 to 99999.999).
:STIMe?	Request the programmed relay settling time.
:SLOT2	Path to configure CARD 2:
:CTYPE <type>	Specify the card type installed in the slot.
:CTYPE?	Request the card type installed in the slot.
:POLE <n>	Select pole mode (1, 2 or 4).
:POLE?	Request the programmed number of poles.
:STIMe <num>	Set relay settling time in seconds (0 to 99999.999).
:STIMe?	Request the programmed relay settling time.
:MEMory	Path to program memory:
:SAVe M<num>	Saves channel pattern at memory location (1-100).
:RECall M<num>	Recalls channel pattern from memory location (1-100).

Table I-2
Syntax of non-SCPI commands implemented by Model 7001

Command	Description
:SENSe[1]	
:TTL1	Command path for input port.
:DATA?	Read digital input port.
:SOURce	Command path to program digital output port bits:
:TTL1	Path to program Bit 1 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 1.
:TTL2	Path to program Bit 2 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 2.
:TTL3	Path to program Bit 3 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 3.
:TTL4	Path to program Bit 4 of output port:
[:LEVel] <b>	Set (1 or ON) or reset (0 or off).
[:LEVel]?	Request status of Bit 4.
:SYSTem	
:POSetup RST | PRESet | SAV0 | SAV1 | SAV2 | SAV3 | SAV4 | SAV5 | SAV6 | SAV7 | SAV8 | SAV9	Select Power-on setup.
:POSetup?	Request Power-on setup.
Trigger commands:	
:ARM[:SEQuence[1]]	Subsystem command path to configure scan:
[:LAYer[1]]	Path to program arm layer of scan:
:SOURce TLINk	Select Arm Layer 1 control source.
:TCONfigure	Path to configure Triggers.
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous Trigger Link mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.

Table I-2
Syntax of non-SCPI commands implemented by Model 7001

Command	Description
LAYer2	Path to program scan layer of scan.
:SOURce TLINk	Select Arm Layer 2 control source.
:TCONfigure	Path to configure Trigger Link:
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:TRIGger[:SEQuence[1]]	Path to program channel layer of scan.
:SOURceTLINk	Select Trigger Layer Control Source.
:TCONfigure	Path to configure Triggers:
:PROTocol ASYNchronous | SSYNchronous	Select protocol (asynchronous or semi-synchronous Trigger Link.)
:PROTocol?	Request programmed protocol.
:DIRection SOURce | ACCeptor	Enable (SOUR) or disable (ACC) Bypass.
:DIRection?	Request the programmed direction.
:ASYNchronous	Path to configure asynchronous Trigger Link mode:
:ILINe <n>	Select input line (1 to 6).
:ILINe?	Request programmed input line.
:OLINe <n>	Select output line (1 to 6).
:OLINe?	Request programmed output line.
:SSYNchronous	Path to configure semi-synchronous Trigger Link mode:
:LINe <n>	Select trigger line (1 to 6).
:LINe?	Request programmed trigger line.

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Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

- ❑ Intermittent
- ❑ Analog output follows display
- ❑ Particular range or function bad; specify _____
- ❑ IEEE failure
- ❑ Obvious problem on power-up
- ❑ Batteries and fuses are OK
- ❑ Front panel operational
- ❑ All ranges or functions are bad
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unstable
- ❑ Overload
- ❑ Unable to zero
- ❑ Will not read applied input

- ❑ Calibration only
- ❑ Data required
- ❑ Certificate of calibration required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

KEITHLEY INSTRUMENTS

Keithley Instruments, Inc.
Instruments Division
28775 Aurora Road
Cleveland, Ohio 44139

7001-901-01 Rev. A / 11-91

Instruction Manual

Models 7011-S and 7011-C

Quad 1 × 10 Multiplexer Cards

Contains Operating and Servicing Information

KEITHLEY INSTRUMENTS

7011-901-01 Rev. A / 11-91

WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

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Models 7011-S and 7011-C Instruction Manual

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Manual Printing History

The printing history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information which the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this printing history page.

Revision A (Document Number 7011-901-01).....November 1991

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture rear panel, or switching card.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC main. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a ⏚ screw is present on the test fixture, connect it to safety earth ground using #18 AWG or larger wire.

The ⚡ symbol on an instrument or accessory indicates that 1000V or more may be present on the terminals. Refer to the product manual for detailed operating information.

Instrumentation and accessories should not be connected to humans.

Maintenance should be performed by qualified service personnel. Before performing any maintenance, disconnect the line cord and all test cables.

7011 SPECIFICATIONS

MODEL 7011-S Quad 1×10 Multiplexer with Screw Terminals.

MODEL 7011-C Quad 1×10 Multiplexer with Mass Terminated Connector.

MULTIPLEX CONFIGURATION: Four independent 1×10 2-pole Multiplex banks or two independent 1×10 4-pole Multiplex banks. Adjacent banks can be connected together. Jumpers can be removed to isolate any bank from the backplane.

CONTACT CONFIGURATION: 2-pole Form A (Hi, Lo).

CONNECTOR TYPE:

7011-S: Screw terminal, #16AWG maximum wire size, with .092 inch O.D. 28 Conductors maximum. #22AWG typical wire size with .062 inch O.D. 88 Conductor maximum.

7011-C: 96-Pin male Euro card connector. Mates to female twisted wire cable, crimp or solder connector.

MAXIMUM SIGNAL LEVEL:

DC Signals: 110V DC between any two pins, 1A switched. 30VA (resistive load).

AC Signals: 125V RMS or 175V AC peak, between any two pins, 1A switched, 60VA (resistive load).

COMMON MODE VOLTAGE: 175V peak, any pin to chassis.

CONTACT LIFE:

Cold Switching: 10^8 closures.

At Maximum Signal Levels: 10^5 closures.

CHANNEL RESISTANCE (per conductor): < 1Ω.

CONTACT POTENTIAL:

7011-S: < 500 nV per contact pair (Hi, Lo).
< 1.5 µV per single contact.

7011-C: < 1.5 µV per contact pair (Hi, Lo) (typically < 1 µV).
< 3.5 µV per single contact (typically < 3 µV).

OFFSET CURRENT: < 100 pA.

ACTUATION TIME: 3 ms.

ISOLATION:

Bank: $>10^9\Omega$, < 25 pF.

Channel to Channel: $>10^9\Omega$, < 50 pF.

Differential: Configured as 1×10 $>10^9\Omega$, < 100 pF.
Configured as 1×40 $>10^9\Omega$, < 200 pF.

Common Mode: Configured as 1×10 $>10^9\Omega$, < 200 pF.
Configured as 1×40 $>10^9\Omega$, < 600 pF.

CROSS TALK (1MHz, 50Ω Load):

Bank: < -40 dB.

Channel: < -40 dB.

INSERTION LOSS (50Ω Source, 50 Load): < 0.1 dB below 1 MHz, < 3 dB below 2 MHz.

RELAY DRIVE CURRENT (per relay): 16 mA.

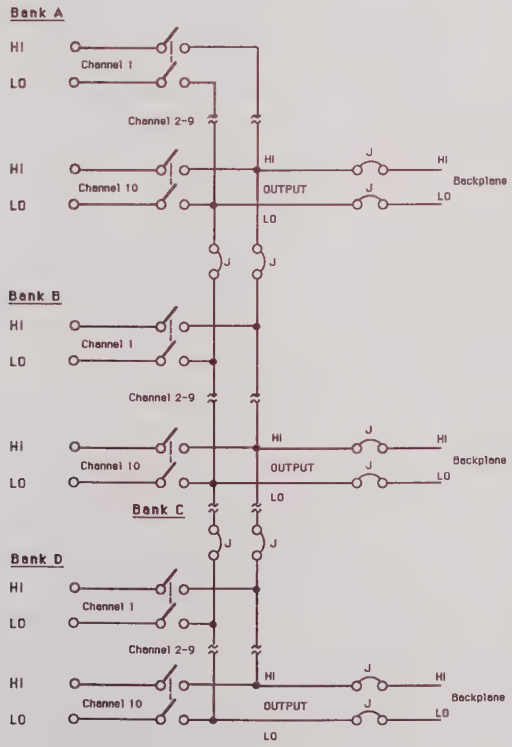
ENVIRONMENT:

Operation: 0°C to 50°C, up to 35°C < 80% RH.

Storage: -25°C to 65°C.

Specifications subject to change without notice.

7011 Quad 1x10 Multiplexer



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1 General Information

1.1 Introduction

This section contains general information about the Model 7011 Quad 1 × 10 Multiplexer card.

There are two basic versions of this multiplexer card; the Model 7011-S and the Model 7011-C. The Model 7011-S assembly consists of a screw terminal connector card and a relay card. External test circuits are wired directly to the screw terminals of the connector card. Also available from Keithley is the Model 7011-ST. This is an extra screw terminal connector card. With an extra connector card, you can wire a second test system without disturbing the wiring configuration of the first test system.

The Model 7011-C assembly consists of a multi-pin (mass termination) connector card and the relay card. External test circuit connections to the multiplexer are made via the 96-pin male DIN connector on the connector card. Keithley offers a variety of optional accessories that can be used to make connections to the connector card (see paragraph 1.9).

The rest of Section 1 is arranged in the following manner:

1.2 Features

1.3 Warranty information

1.4 Manual addenda

1.5 Safety symbols and terms

1.6 Specifications

1.7 Unpacking and inspection

1.8 Repacking for shipment

1.9 Optional accessories

1.2 Features

The Model 7011 is a low voltage, two-pole, quad, 1 × 10 multiplexer card. Some of the key features include:

- Low contact potential and offset current for minimal effects on low-level signals.
- The connector board detaches from the relay board allowing easy access to the screw terminals (Model 7011-S) and jumpers.
- Easy jumper configuration of one, two, three or four multiplexer banks.
- Backplane jumpers. Cutting jumpers disconnects multiplexer bank outputs from the Model 7001 analog backplane.

1.3 Warranty information

Warranty information is located on the inside front cover of this instruction manual. Should your Model 7011 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the multiplexer card for repair, be sure to fill out and include the service form at the back of this manual in order to provide the repair facility with the necessary information.

1.4 Manual addenda

Any improvements or changes concerning the multiplexer card or manual will be explained in an addendum included with the card. Addenda are provided in a page replacement format. Simply replace the obsolete pages with the new pages.

1.5 Safety symbols and terms

The following symbols and terms may be found on an instrument or used in this manual.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the instruction manual.

The symbol on an instrument shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the multiplexer card. Such damage may invalidate the warranty.

1.6 Specifications

Model 7011 specifications are found at the front of this manual. These specifications are exclusive of the multiplexer mainframe specifications.

1.7 Unpacking and inspection

1.7.1 Inspection for damage

The Model 7011 is packaged in a re-sealable, anti-static bag to protect it from damage due to static discharge and from contamination that could degrade its performance. Before removing the card from the bag, observe the following precautions on handling.

Handling Precautions:

1. Always grasp the card by the side edges and shields. Do not touch the board surfaces or components.
2. When not installed in a Model 7001 mainframe, keep the card in the anti-static bag and store it in the original packing carton.

After removing the card from its anti-static bag, inspect it for any obvious signs of physical damage. Report any such damage to the shipping agent immediately.

1.7.2 Shipping contents

The following items are included with every Model 7011 order:

- Model 7011 Quad 1 × 10 Multiplexer Card
- Model 7011 Instruction Manual
- Additional accessories as ordered

1.7.3 Instruction manual

The Model 7011 Instruction Manual is three-hole drilled so that it can be added to the three-ring binder of the Model 7001 Instruction Manual. After removing the plastic wrapping, place the manual in the binder following the mainframe instruction manual. Note that a manual identification tab is included and should precede the multiplexer card instruction manual.

If an additional instruction manual is required, order the manual package, Keithley part number 7011-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.7.4 Repacking for shipment

Should it become necessary to return the Model 7011 for repair, carefully pack the unit in its original packing carton or the equivalent, and include the following information:

- Advise as to the warranty status of the multiplexer card.
- Write ATTENTION REPAIR DEPARTMENT on the shipping label.
- Fill out and include the service form located at the back of this manual.

1.8 Optional accessories

The following accessories are available for use with the Model 7011:

Model 7011-ST — This screw terminal connector card is identical to the one provided with the Model 7011-S assembly. An extra screw terminal connector card allows you to wire a second test system without disturbing the wiring configuration of the first connector card.

Model 7011-KIT-R — This connection kit includes a 96-pin female DIN connector that will mate directly to the connector on the Model 7011-C or to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR). This connector uses solder cups for connections to external circuitry. It includes an adapter for a round cable and the housing.

Model 7011-MTC-2 — This 2-meter round cable assembly is terminated with a 96-pin female DIN connector on each end. It will mate directly to the connector on the Model 7011-C and to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR).

Model 7011-MTR — This 96-pin male DIN bulkhead connector uses solder cups for connections to external circuitry. It will mate to the Model 7011-KIT-R connector, and Model 7011-MTC-2 cable assembly.

2

Multiplexing Basics

2.1 Introduction

This section covers the basics for multiplex switching and is arranged as follows:

2.2 **Basic multiplex configurations:** Covers the basic multiplex configurations; quad 1 × 10 configuration, dual 1 × 20 configuration and single 1 × 40 configuration. The significance of the backplane jumpers is also covered here.

2.3 **Typical multiplex switching schemes:** Explains some of the basic ways a multiplexer can be used to source or measure. Covers single-ended switching, differential (floating) switching and sensing.

2.4 **System expansion:** Discusses the various configurations that are possible by using multiple cards.

2.2 Basic multiplexer configurations

A simplified schematic of the Model 7011 multiplexer is shown in Figure 2-1. It is organized as four 1 × 10 multiplexer banks. Each bank has 10 inputs and one output. Two-pole switching is provided for each multiplexer input, with HI and LO switched. Two or more banks can be jumpered together to expand multiplexer inputs, and backplane jumpers provide bank connections to a second card installed in Model 7001 mainframe.

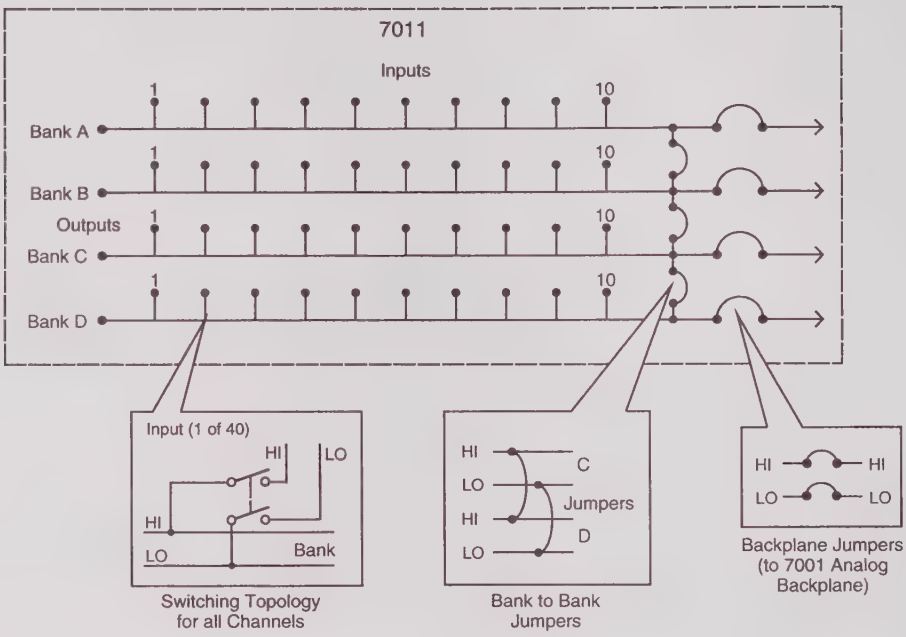


Figure 2-1
Model 7011 simplified schematic

2.2.1 Multiplexer bank-to-bank jumpers

Jumpers are installed on the connector card to connect multiplexer banks together to form a multiplexer of 1 × 40. Each jumper set connects two adjacent banks together. These jumper sets are included with the Model 7011.

The bank-to-bank jumpers allow you to configure the multiplexer card in a variety of ways. Typical multiplexer configurations include:

- Four 1 × 10 multiplexers; no jumpers installed (Figure 2-2).
- Two 1 × 20 multiplexers; Bank A jumpered to Bank B, Bank C jumpered to Bank D (Figure 2-3).
- One 1 × 40 multiplexer; all bank-to-bank jumpers installed (Figure 2-4).

Other combinations are possible, including multiplexers of various sizes (in multiples of 10 channels). For example, you could install jumpers to configure the card as one 1 × 30 and one 1 × 10 multiplexer.

Refer to Section 3 for information on installing bank-to-bank jumpers.

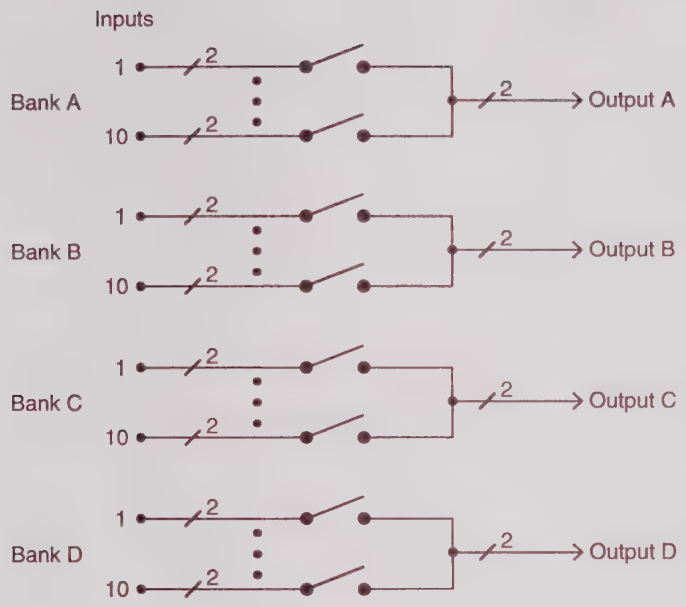


Figure 2-2
Four 1 × 10 multiplexer configuration (jumpers not installed)

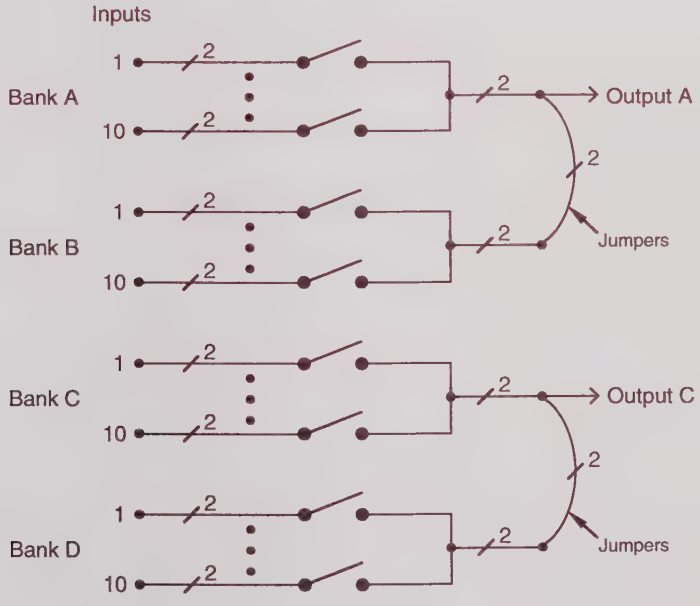


Figure 2-3
Two 1 × 20 multiplexer configuration (jumpers installed)

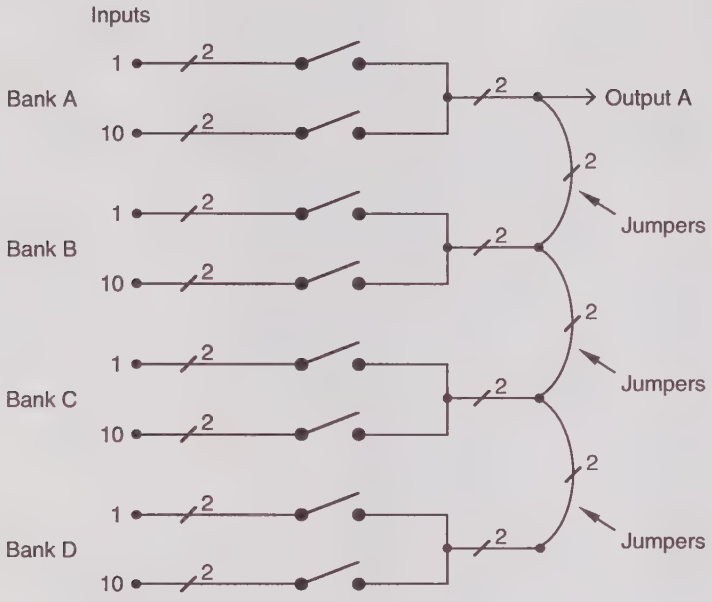


Figure 2-4
One 1 × 40 multiplexer configuration (jumpers installed)

2.2.2 Backplane jumpers

There are four pairs of backplane jumpers located on the relay card. With the jumpers installed, the banks of the multiplexer card are connected to the analog backplane of the Model 7001 allowing expansion with a second 7001 card installed in the mainframe. With the jumpers removed (cut), the multiplexer card is isolated from another card installed in the mainframe.

The three-pole analog backplane of the Model 7001 mainframe is shown in Figure 2-5. Through this analog backplane the banks of a Model 7011 multiplexer card, installed in one slot, can be connected to the banks (or rows) of a compatible card installed in the other slot of the mainframe.

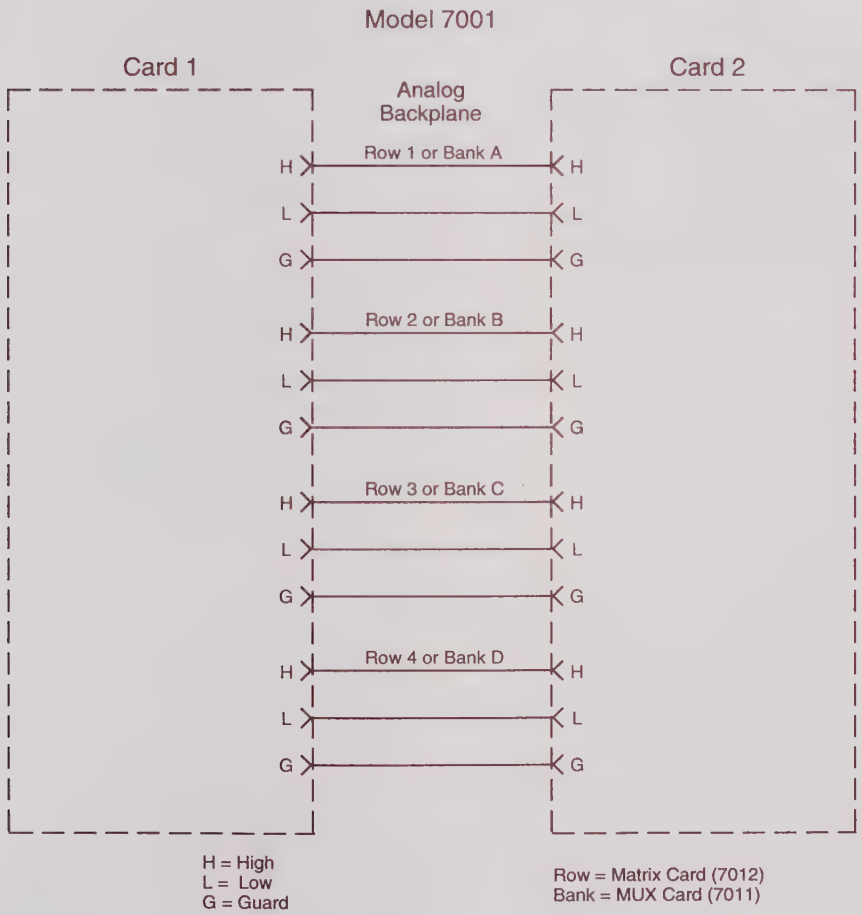


Figure 2-5
Model 7001 analog backplane

Figure 2-6 shows how each bank of the Model 7011 is connected to the backplane. Notice that since the Model 7011 is a two-pole card, there is no connection made to the Guard terminal of the backplane. The Model 7011 is shipped from the factory with the backplane jumpers installed.

Removing (cutting) the backplane jumpers isolates the card from the backplane, and subsequently, any card installed in the other slot. For information on removing the jumpers, refer to Section 3.

NOTE

The Model 7001 does not provide an analog backplane for the non-701X series cards. As a result, any of these cards installed in one slot in the mainframe is electrically isolated from any card installed in the other slot. The only way to connect a Model 7011 to one of these cards is to wire them together.

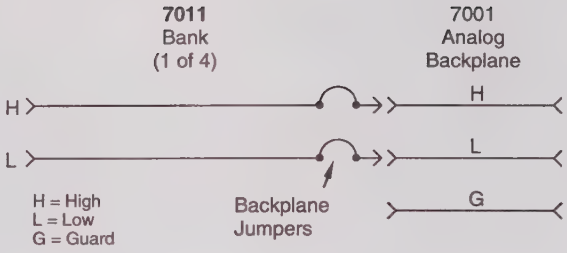


Figure 2-6
Bank connections to backplane

2.3 Typical multiplexer switching schemes

The following paragraphs describe some basic switching schemes that are possible with a two-pole switching multiplexer. These switching schemes include some various shielding configurations to help minimize noise pick up in sensitive measurement applications. These shields are shown connected to chassis ground. For some test configurations, shielding may prove to be more effective connected to circuit common. Chassis ground is accessible at the rear panel of the Model 7001.

2.3.1 Single-ended switching

In the single-ended switching configuration, the source or measure instrument is connected to the DUT through a single pathway as shown in Figure 2-7. The instrument is connected to the output of one of the banks and the DUT is shown connected to one of the inputs for that bank.

2.3.2 Differential switching

The differential or floating switching configuration is shown in Figure 2-8. The advantage of using this configuration is that the terminals of the source or measure instrument are not confined to the same pathway. Each terminal of the instrument can be switched to any available input in the test system.

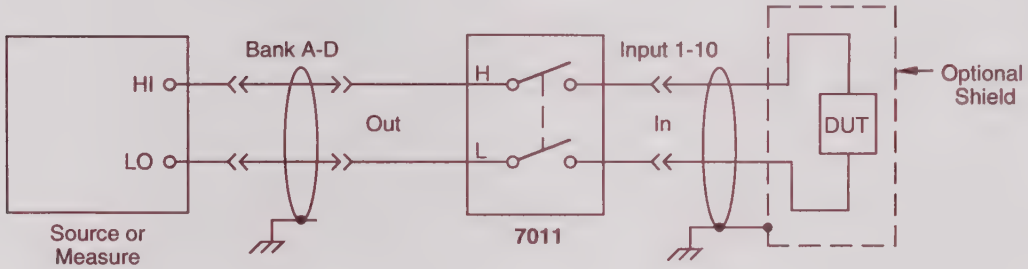


Figure 2-7
Single-ended switching example

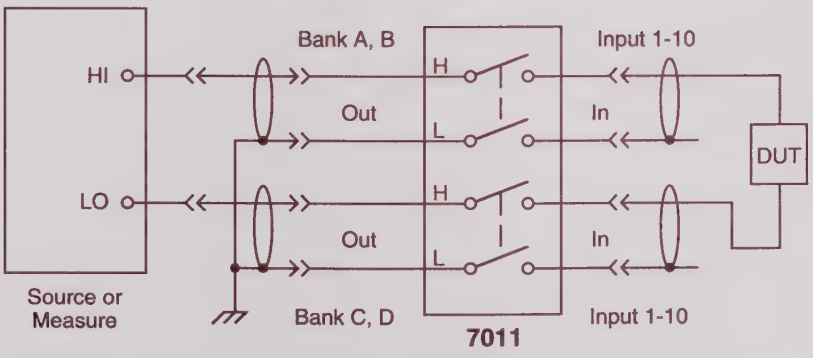


Figure 2-8
Differential switching example

2.3.3 Sensing

Figure 2-9 shows how the multiplexer card can be configured to use instruments that have sensing capability. The main advantage of using sensing is to cancel the effects of switch card path resistance (<1Ω) and the resistance of external cabling. Whenever path resistance is a consideration, sensing should be used.

2.3.4 SMU connections

Figure 2-10 shows how to connect a Keithley Model 236, 237 or 238 Source Measure Unit to the multiplexer card. By using triax cables that are unterminated at one end, the driven guard and chassis ground are physically extended all the way to the card.

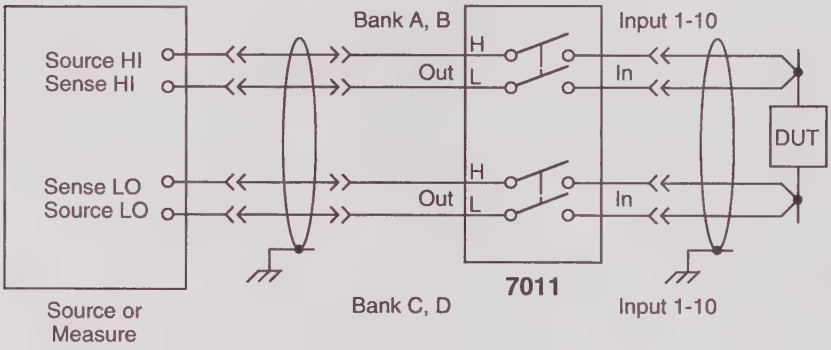
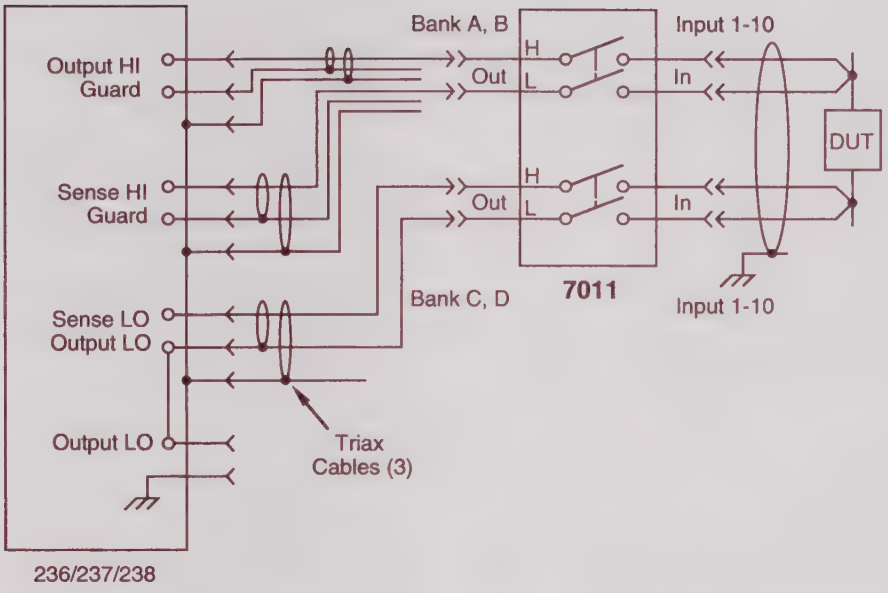


Figure 2-9
Sensing example



WARNING : Hazardous voltages may be present on GUARD. Make sure all cable shields are properly insulated before applying power.

Figure 2-10
SMU connections

2.4 Multiplexer expansion

With the use of additional switching cards and mainframes, larger systems can be configured. Each Model 7001 Switch System mainframe will accommodate up to two cards, and up to six mainframes can be connected together. Thus, a switch system using as many as 12 cards can be configured.

2.4.1 Two-card switching systems

Each Model 7001 Switch System mainframe can accommodate two cards to allow the following switching configurations.

Separate switching systems

Two single-card systems can be configured by removing the backplane jumpers from one of the cards. The two cards will be controlled by the same mainframe, but they will be electrically isolated from each other. Figure 2-11 shows an example using two Model 7011 multiplexer cards.

Multiplexer input expansion

You can double the number of multiplexer inputs by simply installing two "as shipped" Model 7011s in the Model 7001 mainframe. By leaving the backplane jumpers installed, the banks of the multiplexer card installed in slot 1 (CARD 1) are automatically connected to the banks of the multiplexer card installed in slot 2 (CARD 2) through the analog backplane.

Figure 2-12 shows an example of input expansion. Each Model 7011 card is configured as four 1 × 10 multiplexers. By connecting the banks together (via Model 7001 analog backplane), the resultant multiplexer system has 20 inputs for each of the four banks. Notice that if all the bank-to-bank jumpers (for both cards) were installed, the result would be a single 1 × 80 multiplexer.

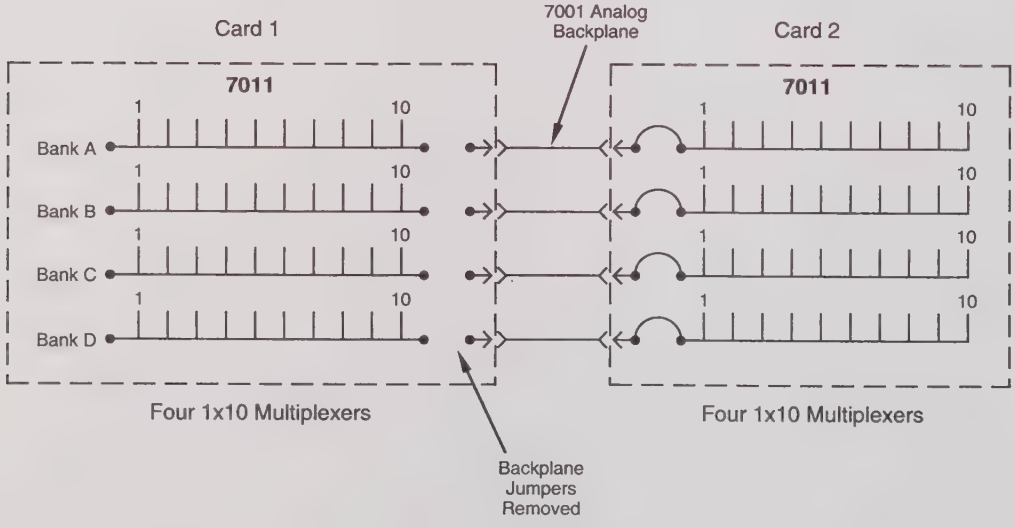


Figure 2-11
Two separate multiplexer systems

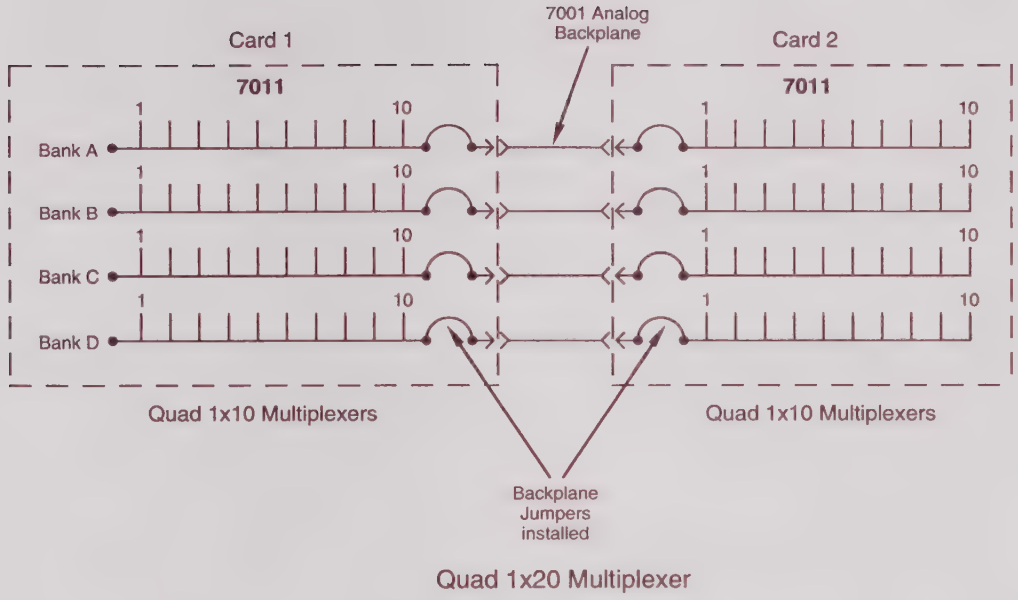


Figure 2-12
Multiplexer input expansion example

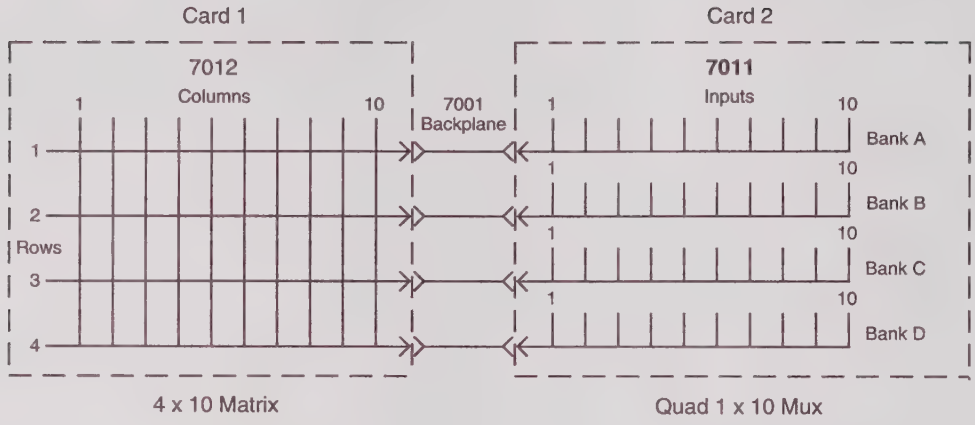
Mixing card types

Different types of cards can be used together to create some unique switching systems. For example, you could have a Model 7011 multiplexer card installed in one slot and a Model 7012 matrix card installed in the other slot.

Figure 2-13 shows a possible switching system using a matrix card and a multiplexer card. The backplane jumpers for both the matrix and multiplexer cards must be installed. This allows matrix rows to be connected to multiplexer banks. On the multiplexer card, the bank-to-bank jumpers must be removed to maintain isolation between matrix rows. See the instruction manual for the Model 7012 for complete information on the matrix card.

2.4.2 Mainframe multiplexer expansion

Multiplexer systems using up to 12 multiplexer cards are possible by using six Model 7001 mainframes together. Each Model 7011 added to the system provides 40 additional inputs. Paragraph 3.4.3 explains how to connect a test system using two mainframes.



Notes : 1. Models 7011 and 7012 backplane jumpers must be installed.
2. Model 7011 bank-to-bank jumpers must be removed.

Figure 2-13
Mixed card type example

3

Card Connections & Installation

3.1 Introduction

WARNING

The procedures in this section are intended only for qualified service personnel. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

The information in this section is arranged as follows:

3.2 **Handling precautions:** Explains precautions that must be followed to prevent contamination to the multiplexer card assembly. Contamination could degrade the performance of the multiplexer card.

3.3 **Connections:** Covers the basics for connecting external circuitry to the two available connector cards for the multiplexer; the screw terminal connector card and the multi-pin connector card.

3.4 **Typical connection schemes:** Provides some typical connection schemes for single card, two-card and two-mainframe system configurations.

3.5 **Model 7011 installation:** Provides a procedure to install the multiplexer card assembly in the Model 7001 mainframe.

3.2 Handling precautions

To maintain high impedance isolation, care should be taken when handling the relay card to avoid contamination from such foreign materials as body oils. Such contamination can substantially lower leakage resistances, thus degrading performance.

To avoid possible contamination, always grasp the relay and connector cards by the side edges or shields. Do not touch the board surfaces or components. On connectors, do not touch areas adjacent to the electrical contacts. Dirt build-up over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and multiplexer card in a clean environment.

If a card becomes contaminated, it should be thoroughly cleaned as explained in paragraph 5.2.

3.3 Connections

This paragraph provides the basic information needed to connect your external test circuitry to the multiplexer. It includes the installation of the bank-to-bank jumpers on the connector card, installation/removal of backplane jumpers on the relay card, and detailed in-

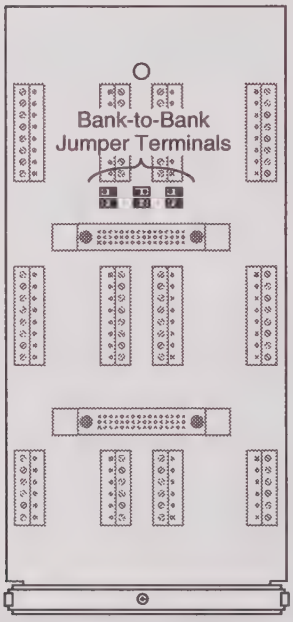
formation on making external connections to the two available connector cards.

WARNING

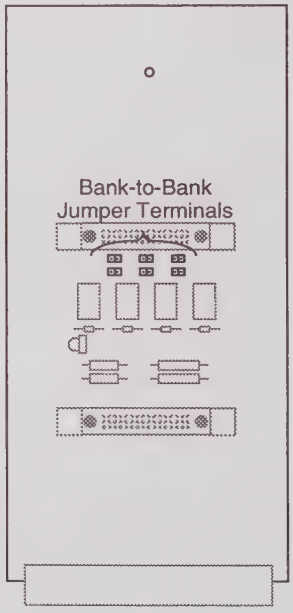
The following connection information is intended to be used by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

3.3.1 Bank-to-bank jumpers

As explained in paragraph 2.2.1, the banks of the multiplexer card can be connected together (using plug-in jumpers) to form larger multiplexers. The locations of the bank-to-bank jumper terminals for both connector cards are shown in Figure 3-1.



A. Screw Terminal Connector Card



B. Multi-pin Connector Card

Figure 3-1
Bank-to-bank jumper locations

Terminal identification is provided by Figure 3-2. On the drawing, the six terminal pairs are labeled W100 through W105. The top three terminal pairs (W101, W103 and W105) are used to connect the LO terminals of the banks together. The bottom terminal pairs (W100, W102 and W104) are used to connect the HI terminals of the banks together. Table 3-1 summarizes the effects of each jumper.

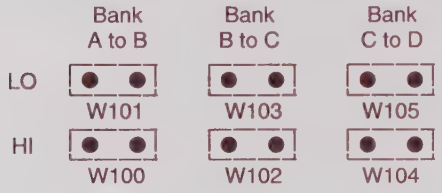


Figure 3-2
Bank-to-bank jumper terminal identification

Table 3-1
Bank-to-bank jumpers (refer to Figure 3-2)

Installed jumper	Effect
W101	Connect Bank A LO to Bank B LO
W100	Connect Bank A HI to Bank B HI
W103	Connect Bank B LO to Bank C LO
W102	Connect Bank B HI to Bank C HI
W105	Connect Bank C LO to Bank D LO
W104	Connect Bank C HI to Bank D HI

Referring to Figure 3-1 for jumper locations, perform the following steps to install bank-to-bank jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Refer to Figure 3-2 and Table 3-1 to determine which jumpers to install.
3. Using Figure 3-3 as a guide, install the jumpers on the appropriate terminal pairs.

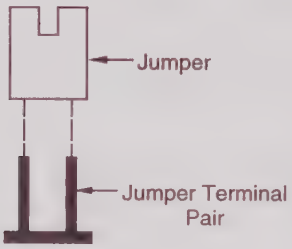


Figure 3-3
Bank-to-bank jumper installation

3.3.2 Backplane jumpers

The Model 7001 mainframe has an analog backplane that allows the banks of a Model 7011 multiplexer to be internally connected to a compatible switching card installed in the other slot (see paragraph 2.4.1 for details).

The backplane jumpers for the multiplexer card assembly are located on the relay card as shown in Figure 3-4. The card is shipped from the factory with the jumpers installed.

Jumper removal

Perform the following steps to remove backplane jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Use Figure 3-4 to locate the jumper(s) that are to be removed.
3. It is not necessary to physically remove the jumpers from the PC board. Using a pair of wire cutters, cut one lead of each jumper.

Jumper installation

Referring to Figure 3-4 for jumper locations, perform the following steps to install backplane row jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Physically remove a cut jumper by unsoldering it from the PC board.
3. Install a new #22 AWG jumper wire (Keithley P/N J-15) and solder it to the PC board.
4. Remove the solder flux from the PC board The cleaning procedure is explained in paragraph 5.2.

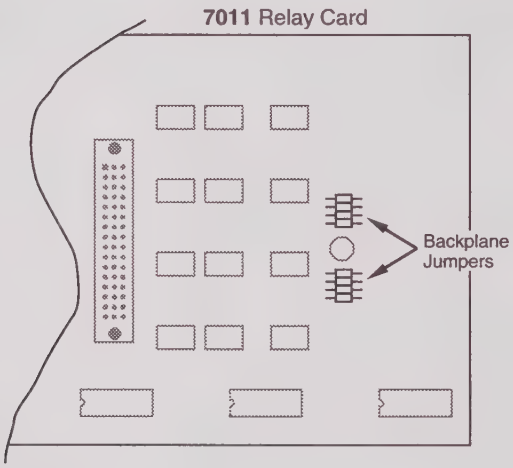


Figure 3-4
Backplane jumpers

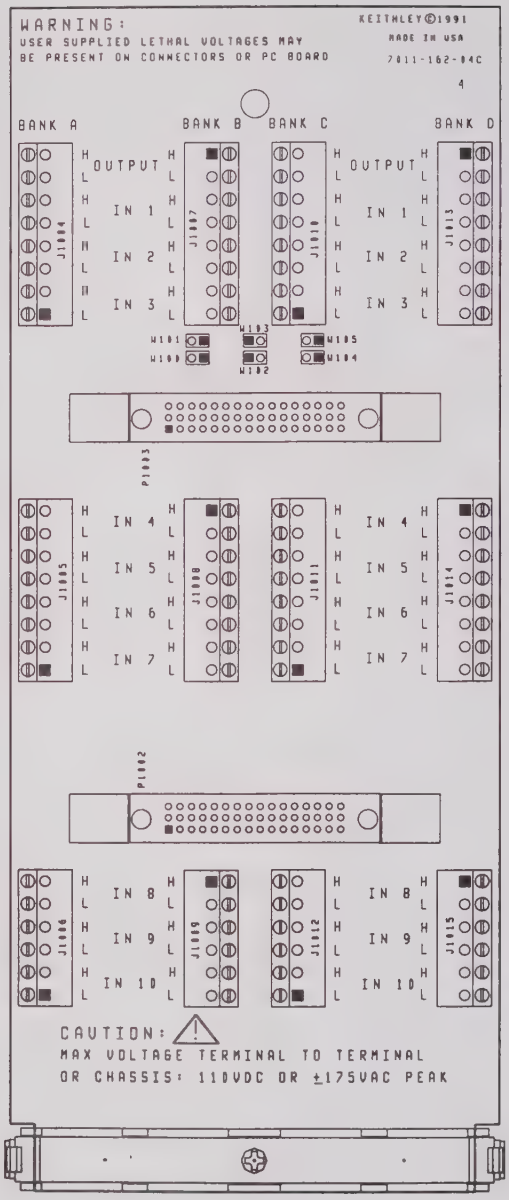


Figure 3-5
Model 7011 screw terminal connector card

3.3.3 Screw terminal connector card

The screw terminal connector card is shown in Figure 3-5. Connections are made directly to the screw terminals of the twelve terminal blocks. Each screw terminal will accommodate #16-22 AWG wire.

Wiring procedure

Perform the following procedure to wire circuitry to the screw terminal connector card:

WARNING

Make sure all power is off and any stored energy in external circuitry is discharged.

1. If mated together, separate the connector card from the relay card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Using an insulated screwdriver, connect the circuitry to the appropriate terminals. Figure 3-6 shows how the output of Bank A would be connected to a DMM.
3. Referring to Figure 3-7, remove the top half of the cable clamp as follows:
   A. Loosen the cable clamp screw enough to disengage it from the bottom half of the cable clamp.
   B. Using your thumb and forefinger, press the retaining clips inward and, with your other hand, remove the top half of the clamp.
4. Route wires under wire guide/connector shim.
5. Route the wires through the bottom half of the cable clamp.
6. Replace the top half of the clamp. It simply snaps onto the bottom half of the clamp. Tighten the cable clamp screw. The clamp serves as a strain relief for terminal block wires.
7. Mate the connector card to the relay card. The Model 7011 is now ready to be installed in the Model 7001 mainframe. See paragraph 3.5 for details.

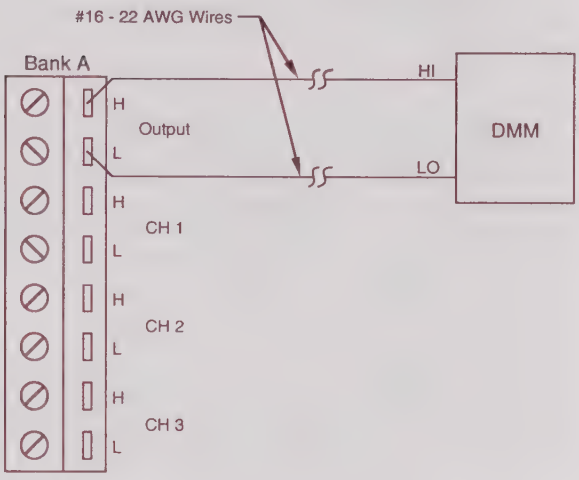


Figure 3-6
Typical screw terminal connections

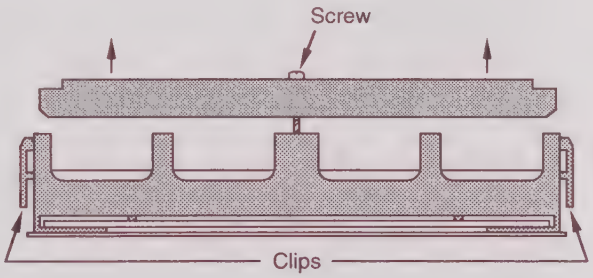


Figure 3-7
Cable clamp for screw terminal connector card

3.3.4 Multi-pin (mass termination) connector card

Since connections to external circuitry are made at the 96-pin male DIN bulkhead connector, there is no need to separate the connector card from the relay card. If the connector card is separated from the relay card, carefully mate them together and install the supplied 4-40 mounting screw. Make sure to handle the cards by the edges and shields to avoid contamination.

Terminal identification for the DIN connector of the multi-pin connector card is provided by Figure 3-8. This connector will mate to a 96-pin female DIN connector.

Keithley has a variety of cable and connector accessories available to accommodate connections from the connector card to test instrumentation and DUT (devices under test). In general, these accessories, which are summarized in Table 3-2, utilize a round cable assembly for connections.

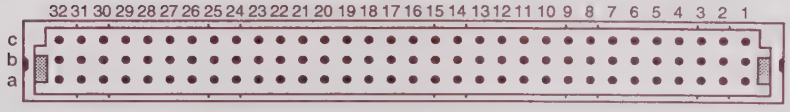
Table 3-2
Mass termination accessories

Model	Description
7011-KIT-R	96-pin female DIN connector and housing for round cable.
7011-MTC-2	Two-meter round cable assembly terminated with a 96-pin female DIN connector on each end.
7011-MTR	96-pin male DIN bulkhead connector.

Pins of the Model 7011-C mass termination connector can be identified in one of three ways:

1. Mux terminal, consisting of banks A-D and inputs 1-10.
2. Connector description, consisting of rows a-c and columns 1-32.
3. Schematic and component layout designation (1-96).

The following pinout diagrams show the correspondence between these arrangements:



Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal		Connector Desig. 1a-32c	Schem. Desig. 1-96
Bank A				Bank B				Bank C				Bank D			
Input 1	HI	32c	96	Input 1	HI	24c	88	Input 1	HI	16c	80	Input 1	HI	8c	72
	LO	32b	64		LO	24b	56		LO	16b	48		LO	8b	40
Input 2	HI	32a	32	Input 2	HI	24a	24	Input 2	HI	16a	16	Input 2	HI	8a	8
	LO	31c	95		LO	23c	87		LO	15c	79		LO	7c	71
Input 3	HI	31b	63	Input 3	HI	23b	55	Input 3	HI	15b	47	Input 3	HI	7b	39
	LO	31a	31		LO	23a	23		LO	15a	15		LO	7a	7
Input 4	HI	30c	94	Input 4	HI	22c	86	Input 4	HI	14c	78	Input 4	HI	6c	70
	LO	30b	62		LO	22b	54		LO	14b	46		LO	6b	38
Input 5	HI	30a	30	Input 5	HI	22a	22	Input 5	HI	14a	14	Input 5	HI	6a	6
	LO	29c	93		LO	21c	85		LO	13c	77		LO	5c	69
Input 6	HI	29b	61	Input 6	HI	21b	53	Input 6	HI	13b	45	Input 6	HI	5b	37
	LO	29a	29		LO	21a	21		LO	13a	13		LO	5a	5
Input 7	HI	28c	92	Input 7	HI	20c	84	Input 7	HI	12c	76	Input 7	HI	4c	68
	LO	28b	60		LO	20b	52		LO	12b	44		LO	4b	36
Input 8	HI	28a	28	Input 8	HI	20a	20	Input 8	HI	12a	12	Input 8	HI	4a	4
	LO	27c	91		LO	19c	83		LO	11c	75		LO	3c	67
Input 9	HI	27b	59	Input 9	HI	19b	51	Input 9	HI	11b	43	Input 9	HI	3b	35
	LO	27a	27		LO	19a	19		LO	11a	11		LO	3a	3
Input 10	HI	26c	90	Input 10	HI	18c	82	Input 10	HI	10c	74	Input 10	HI	2c	66
	LO	26b	58		LO	18b	50		LO	10b	42		LO	2b	34
Output	HI	26a	26	Output	HI	18a	18	Output	HI	10a	10	Output	HI	2a	2
	LO	25c	89		LO	17c	81		LO	9c	73		LO	1c	65

Notes: 1. Pins 9a and 9b (pins 9 and 41 on schematic) are shield.
2. Short pins 1a to 1b on the mating connector (pins 1 and 33 on schematic) to allow the output relays on the connector card to close.

Figure 3-8
Multi-pin card terminal identification

Typical connection techniques

All external circuitry, such as instrumentation and DUTs, that you wish to connect to the multiplexer card must be terminated with a single 96-pin female DIN connector. The following connection techniques provide some guidelines and suggestions for wiring your circuitry.

WARNING

Before beginning any wiring procedures, make sure all power is off and any stored energy in external circuitry is discharged.

NOTE

External circuitry should be connected (plugged in) only with the 7001's power off, after the Model 7011 assembly is installed in the Model 7001 mainframe. Installation is covered in paragraph 3.5.

Output relays— The multi-pin connector card uses a relay for each of the four output banks. These output relays are normally open to prevent any hazardous voltages (via the mainframe backplane) from appearing on the pins of the male DIN connector. The output relays will only close when the Model 7011-MTC-2 cable assembly is connected to card. If building you own cable assembly, you must make sure that it shorts pins 1a to 1b of the card connector (Figure 3-8) when it is mated to the card. Shorting pins 1a to 1b allows the output relays to close.

Round cable assemblies — Figure 3-9 shows typical round cable connection techniques using accessories available from Keithley.

In Figure 3-9A, connections are accomplished using a Model 7011 MTC-2 cable and a Model 7011-MTR bulkhead connector. The two-meter round cable is terminated with a 96-pin female DIN connector at each end. This cable mates directly to the multi-pin connector card and to the bulkhead connector. The bulkhead connector has solder cups to allow direct connection to instrumentation and DUT. Figure 3-10 provides the pinout for the bulkhead connector.

In Figure 3-9B, connections are accomplished using a Model 7011 MTC-2 cable assembly that is cut in half. The 96-pin female DIN connector on one end of the cable mates directly to the multi-pin connector card. The unterminated end of the cable is wired directly to instrumentation and DUT. The other half of the cable assembly could be used for a second switching card.

In Figure 3-9C, connections are accomplished using a custom-built cable assembly that consists of a Model 7011-KIT-R connector and a suitable round cable. Hitachi cable part number N2807-P/D-50TAB is a 50-conductor cable. Two of these cables can be used to supply 100 conductors.The connector has solder cups to accommodate the individual wires of the unterminated cable. Figure 3-11 provides an exploded view of the connector assembly and shows how the cable is connected. The connector end of the resultant cable assembly mates directly to the multi-pin connector card. The unterminated end of the cable assembly is wired directly to instrumentation and DUT.

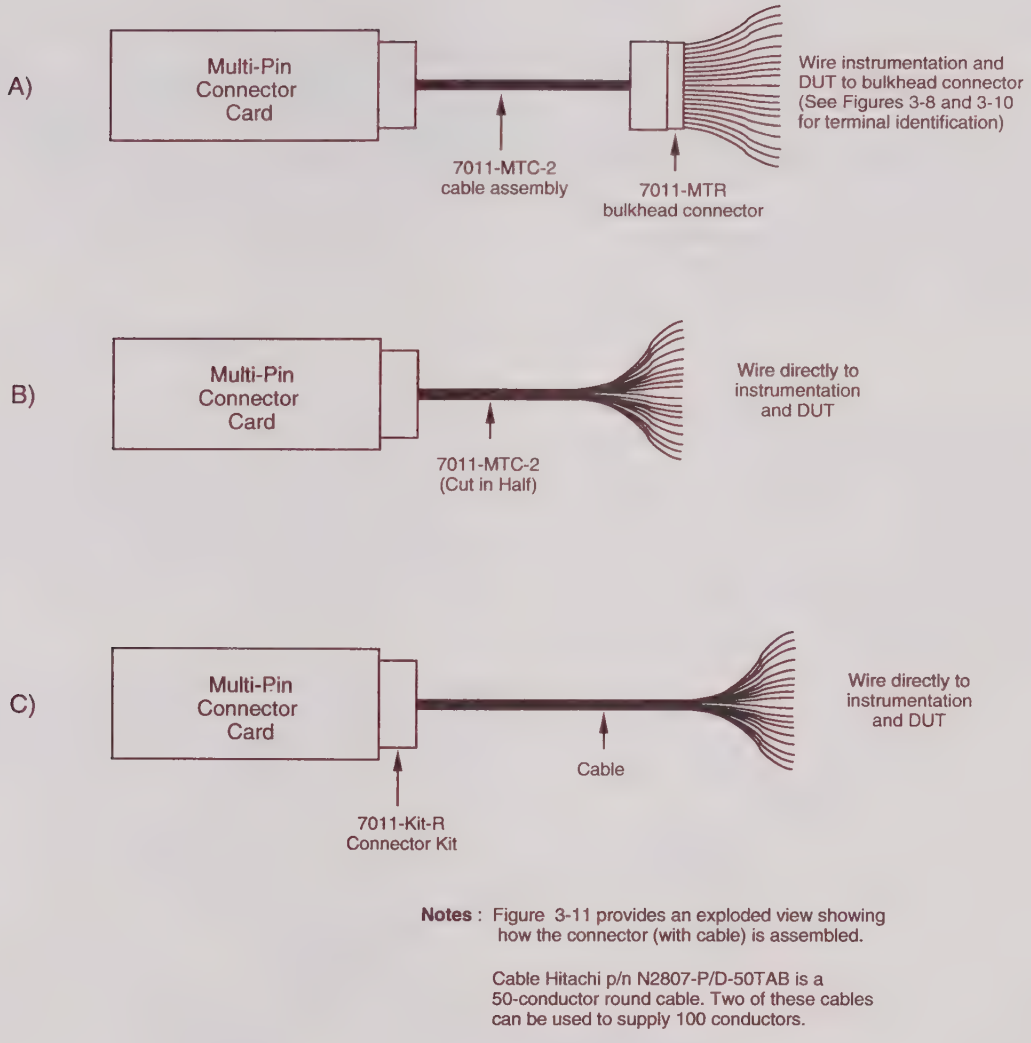
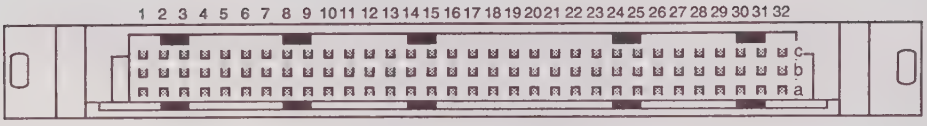

A)
Multi-Pin Connector Card
7011-MTC-2 cable assembly
7011-MTR bulkhead connector
Wire instrumentation and DUT to bulkhead connector (See Figures 3-8 and 3-10 for terminal identification)
B)
Multi-Pin Connector Card
7011-MTC-2 (Cut in Half)
Wire directly to instrumentation and DUT
C)
Multi-Pin Connector Card
7011-Kit-R Connector Kit
Cable
Wire directly to instrumentation and DUT
Notes : Figure 3-11 provides an exploded view showing how the connector (with cable) is assembled.
Cable Hitachi p/n N2807-P/D-50TAB is a 50-conductor round cable. Two of these cables can be used to supply 100 conductors.

Figure 3-9
Typical round cable connection techniques



Note : See Figure 3-8 for terminal identification.

Figure 3-10
Model 7011-MTR connector pinout

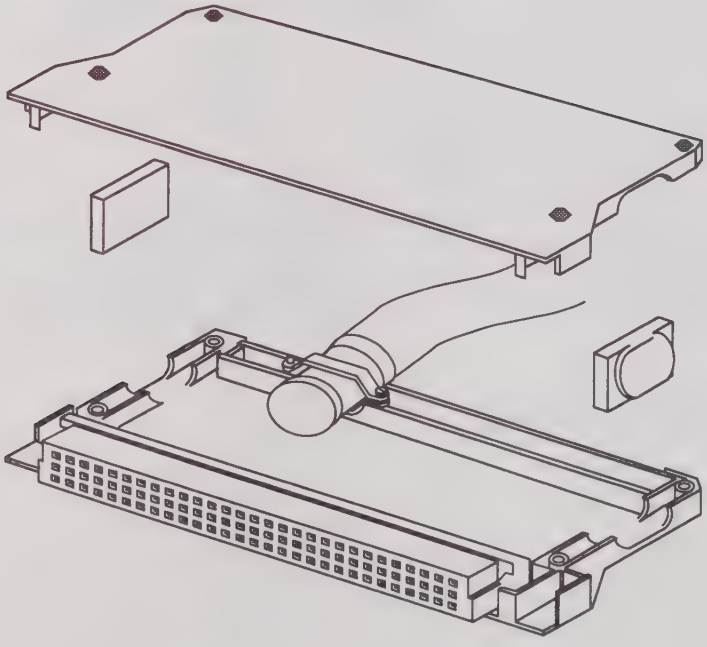


Figure 3-11
Model 7011-KIT-R (with/cable) assembly

3.4 Typical connection schemes

The following information provides some typical connection schemes for single card, two-card and two-mainframe system configurations. Connection schemes for the multi-pin connector card use some of the techniques presented in paragraph 3.3.2. Keep in mind that these are only examples to demonstrate various ways to wire a test system. Connection details for both connector cards (multi-pin and screw terminal connector cards) are provided in paragraph 3.3.

3.4.1 Single card system

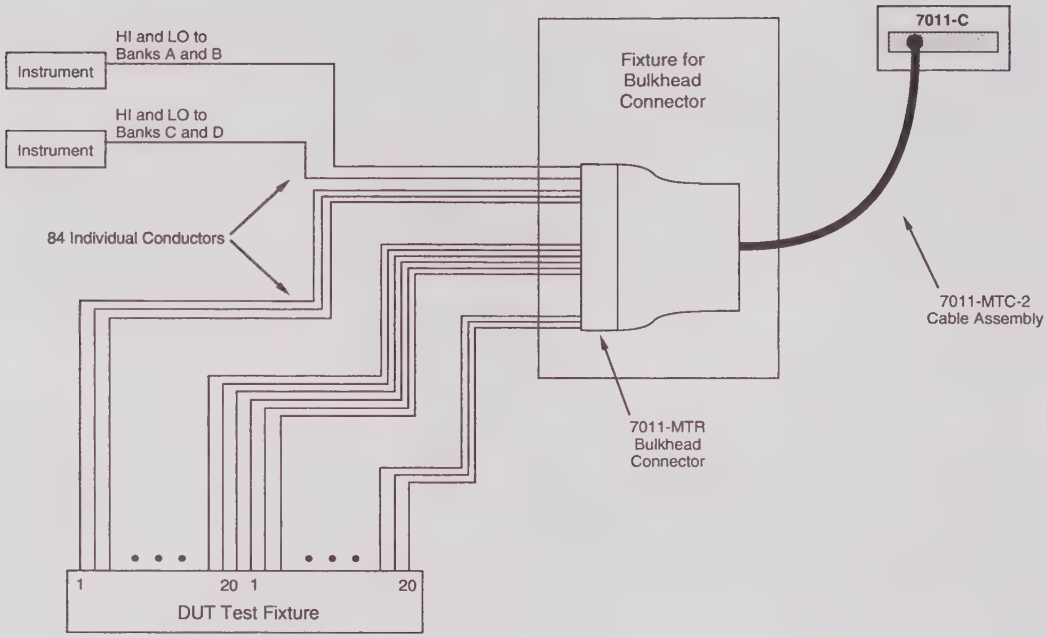
Figure 3-12 shows how external connections can be made to a single card system that uses the multi-pin connector card. This single card system is configured as two 1 × 20 multiplexers. To accomplish this, the appropriate bank-to-bank jumpers must be installed to connect Banks A and B together and Banks C and D together.

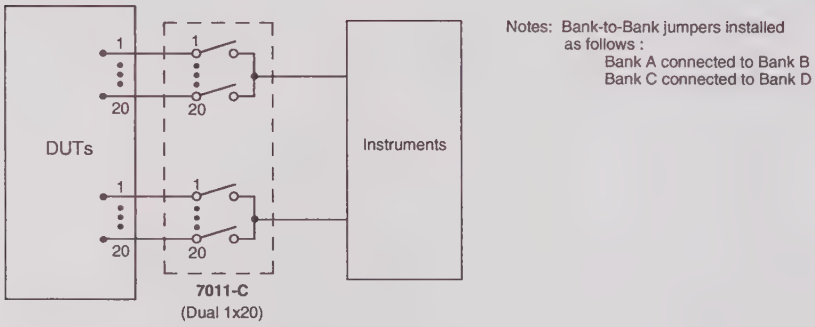
Instrumentation and DUTs are hard-wired to the Model 7011-MTR male bulkhead connector. This connector has solder cups that will accept wire size up to #24 AWG. The test system is connected to the multiplexer using the Model 7011-MTC-2 round cable assembly. This cable mates directly to both the external bulkhead connector and the Model 7011-C multiplexer card assembly. Notice that the bulkhead connector is shown mounted to a fixture to help keep the cabling stable during the test.

The single card system in Figure 3-13 is identical to the system in the previous illustration, except for the connection scheme. The system in Figure 3-13 uses the screw terminal connector card. With this card, single conductor connections are made directly from the terminal blocks of the connector card to instrumentation and DUTs.

When using a single card system, you will want to make sure that the card remains electrically isolated from any other switching cards. There are several ways to ensure isolation for a single card in the Model 7001 mainframe:

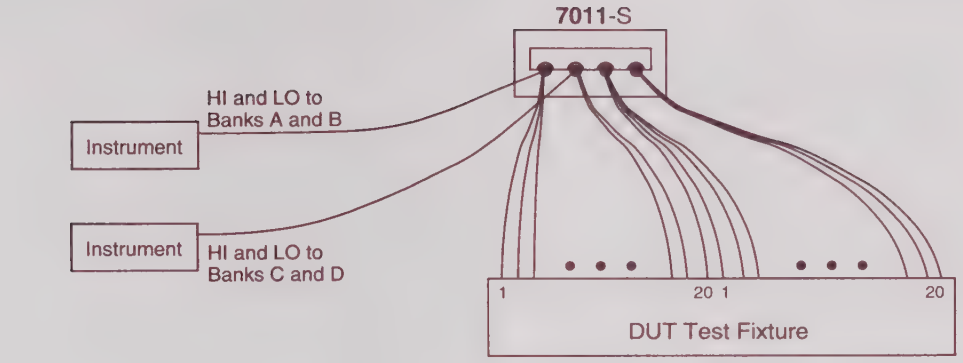
1. Vacate the other mainframe slot. If there is a Model 701X card installed in the other slot, remove it.
2. Remove the backplane jumpers on the multiplexer card. This will disconnect the card from the analog backplane of the mainframe.
3. Remove the backplane jumpers from the switching card installed in the other slot.

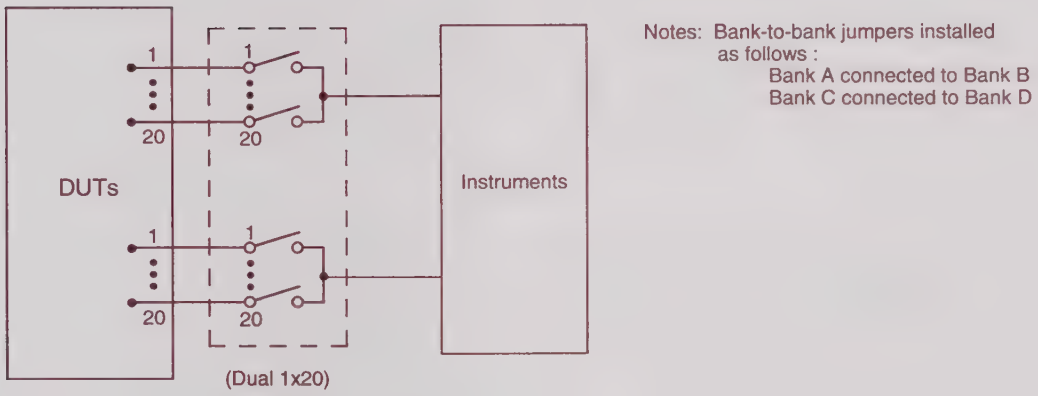




Simplified Equivalent Circuit

Figure 3-12
Single card system example (multi-pin connector card)





Simplified Equivalent Circuit

Figure 3-13
Single card system example (screw terminal connector card)

3.4.2 Two-card system

Both Figure 3-14 and Figure 3-15 show a system using two multiplexer cards installed in one Model 7001 mainframe to configure a single 1 × 80 multiplexer system. Each card is configured as a single 1 × 40 multiplexer. To accomplish this, all bank-to-bank jumpers (both cards) are installed to connect Banks A, B, C, and D together. By leaving the backplane jumpers of both cards installed, the banks of Card 1 are connected to the banks of Card 2 through the analog backplane of the Model 7001 mainframe resulting in the 1 × 80 configuration.

Figure 3-14 shows how external connections can be made for the multi-pin connector cards. In this example, a single Model 7011-MTC-2 round cable assembly is cut in half to provide two cables, each of which is unterminated at one end. The unterminated ends of the two cables are hard-wired to the instrument and DUT as shown in the drawing. The other ends of these cables mate directly to the Model 7011-C multiplexer card assemblies.

Figure 3-15 shows how external connections can be made for the screw terminal connector card. Single conductor connections are made directly from the screw terminals of the connector card to the instrument and DUT.

3.4.3 Two-mainframe system

Both Figure 3-16 and Figure 3-17 show a system using three multiplexer cards installed in two Model 7001 mainframes to configure a single 1 × 120 multiplexer system. Each card is configured as a single 1 × 40 multiplexer. To accomplish this, bank-to-bank jumpers of all three cards must be installed to connect Banks A, B, C, and D together.

By leaving the backplane jumpers of the cards in mainframe #1 installed, the banks of Card 1 are connected to the banks of Card 2 through the analog backplane of the Model 7001 mainframe resulting in a 1 × 80 configuration. External bank connections from the instrument to the card in the second mainframe connect the banks of all three cards together to form the 1 × 120 multiplexer system. This system is similar to the Two-card System (see previous paragraph) except that a third multiplexer card (installed in a second mainframe) is added.

Figure 3-16 shows the connection scheme for the multi-pin connector cards. External circuit connections to the Model 7001 #1 mainframe are identical to the ones used for the Two-card System. The third multiplexer card (installed in Model 7001 #2 mainframe) shows how a custom-built cable can be used to make connections to external circuitry. A suitable round cable can be constructed using a 96-pin female DIN connector (Model 7011-KIT-R) with two lengths of Hitachi cable P/N N2807-P/D-50TAB. This cable contains 50 conductors; two lengths provide 100 conductors. This cable will mate to the Model 7011-C multiplexer card assembly. The unterminated end of the cable is connected directly to the instrument and DUT. Notice that the bank connections for the third multiplexer card are made at the instruments.

Figure 3-17 shows connections for the screw terminal connector card. Single conductor connections are made directly from the screw terminals of the connector card to the instrument and DUT.

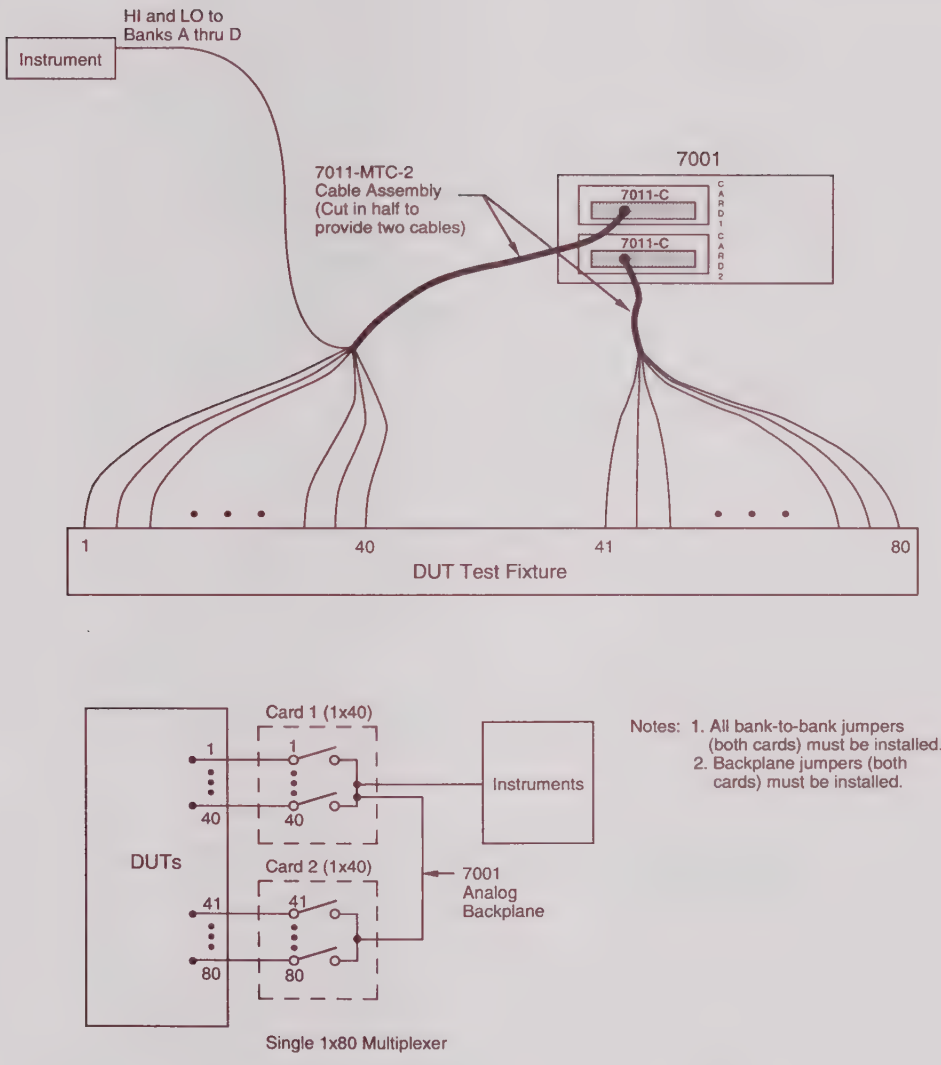
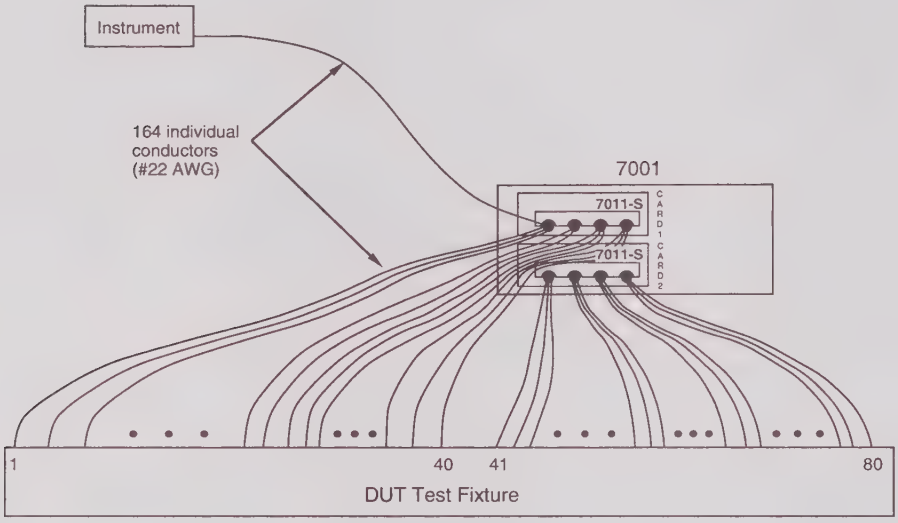
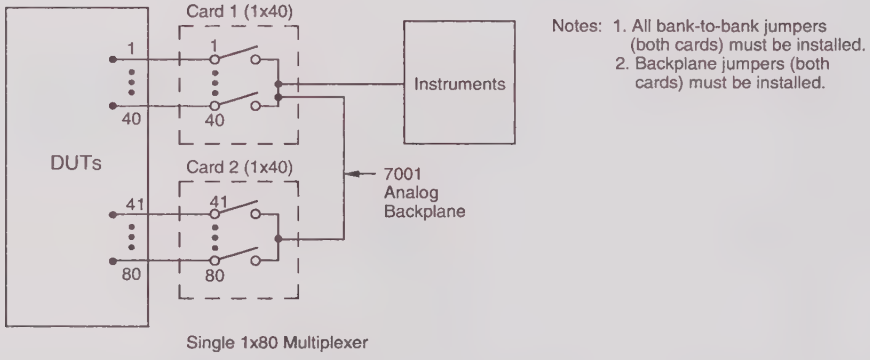


Figure 3-14
Two-card system example (multi-pin connector card)

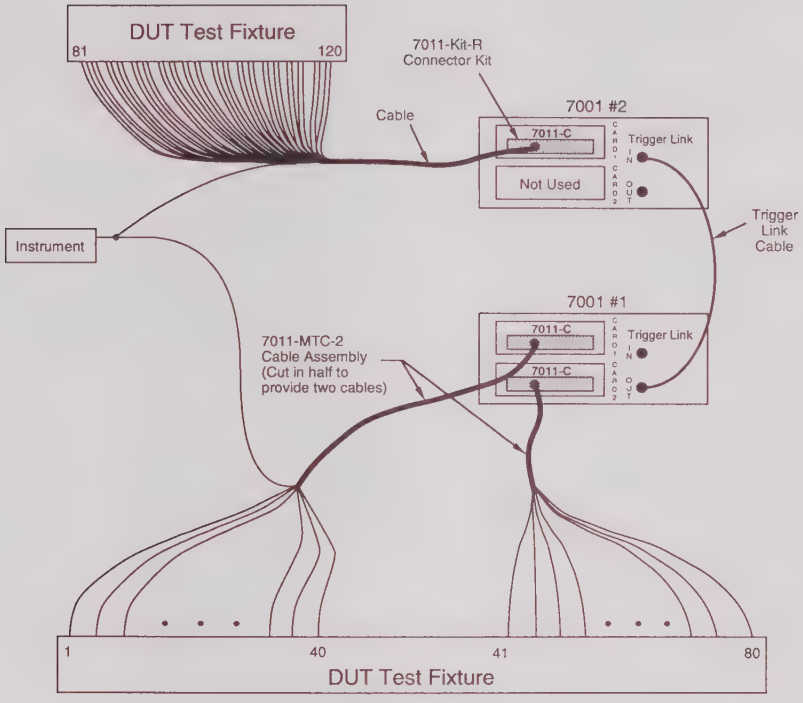


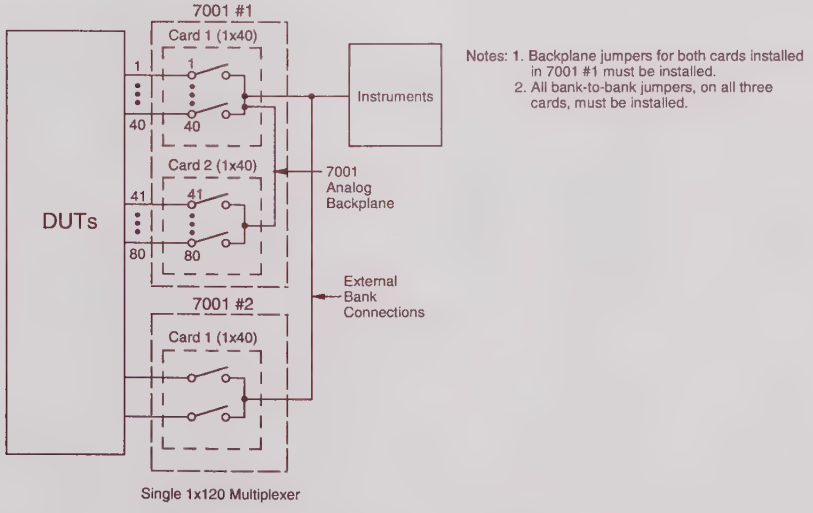


Notes: 1. All bank-to-bank jumpers (both cards) must be installed.
2. Backplane jumpers (both cards) must be installed.

Simplified Equivalent Circuit

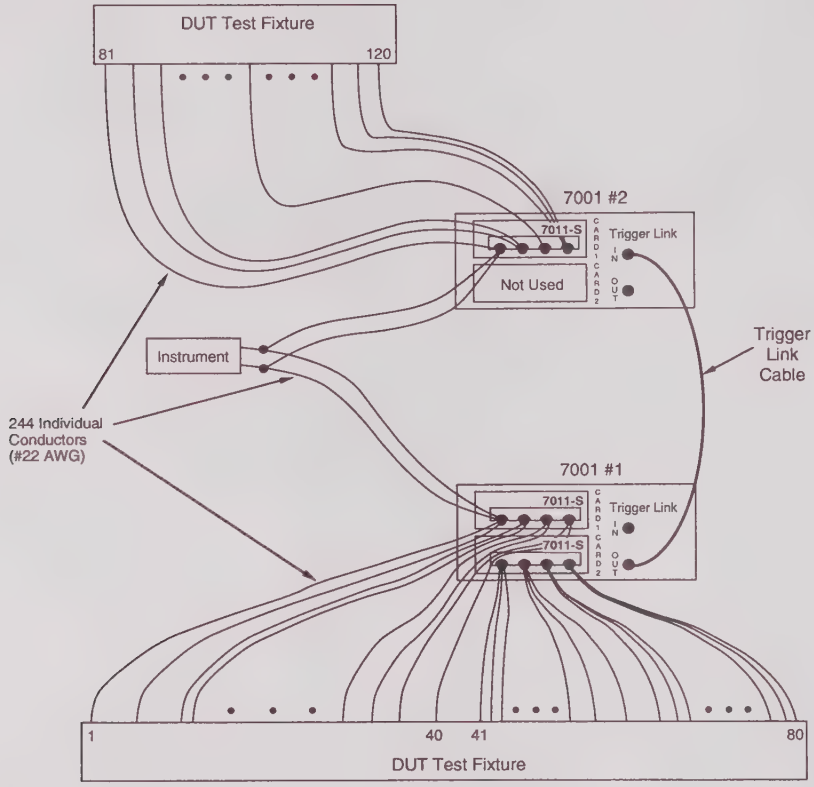
Figure 3-15
Two-card system example (screw terminal connector card)

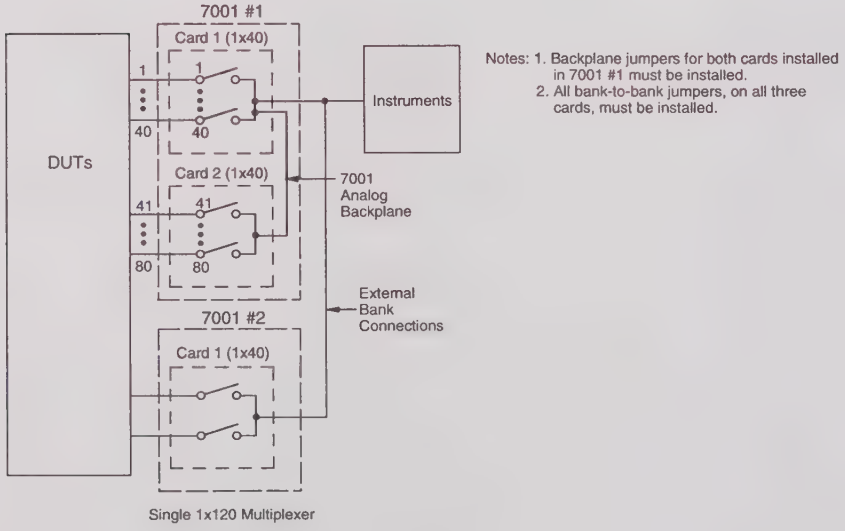




Simplified Equivalent Circuit

Figure 3-16
Two-mainframe system example (multi-pin connector card)





Simplified Equivalent Circuit

Figure 3-17
Two-mainframe system example (screw terminal connector card)

3.5 Model 7011 installation and removal

This paragraph explains how to install and remove the Model 7011 multiplexer card assembly from the Model 7001 mainframe.

WARNING

Installation or removal of the Model 7011 is to be performed by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

NOTE

If using the screw terminal connector card, make sure your external circuitry is wired to the card (as explained in paragraph 3.3.1) before installing the card assembly in the Model 7001 mainframe.

CAUTION

To prevent contamination to the multiplexer card that could degrade performance, only handle the card assembly by the edges and shields.

Multiplexer card installation

Perform the following steps to install the multiplexer card assembly in the Model 7001 mainframe:

WARNING

Turn off power from all instrumentation (including the Model 7001 mainframe) and disconnect their line cords. Make sure all power is removed and any stored energy in external circuitry is discharged.

1. Mate the connector card to the relay card if they are separated. Install the supplied 4-40 screw at the end of the card to secure the assembly. Make sure to handle the cards by the edges and shields to prevent contamination.
2. Facing the rear panel of the Model 7001, select the slot (CARD 1 or CARD 2) that you wish to install the card in.
3. Referring to Figure 3-18 for Model 7011-C installation, or Figure 3-19 for Model 7011-S installation, feed the multiplexer card assembly into the desired slot such that the edges of the relay card ride in the rails.
4. With the ejector arms in the unlocked position, push the card assembly all the way into the mainframe until the arms engage into the ejector cups. Then push both arms inward to lock the card into the mainframe.
5. For the 7011-C, also install the screw shown in Figure 3-18.

Multiplexer card removal

To remove the multiplexer card assembly, first unlock it by pulling the latches outward, then pull the card assembly out of the mainframe. Remember to handle the card assembly by the edges and shields to avoid contamination that could degrade performance.

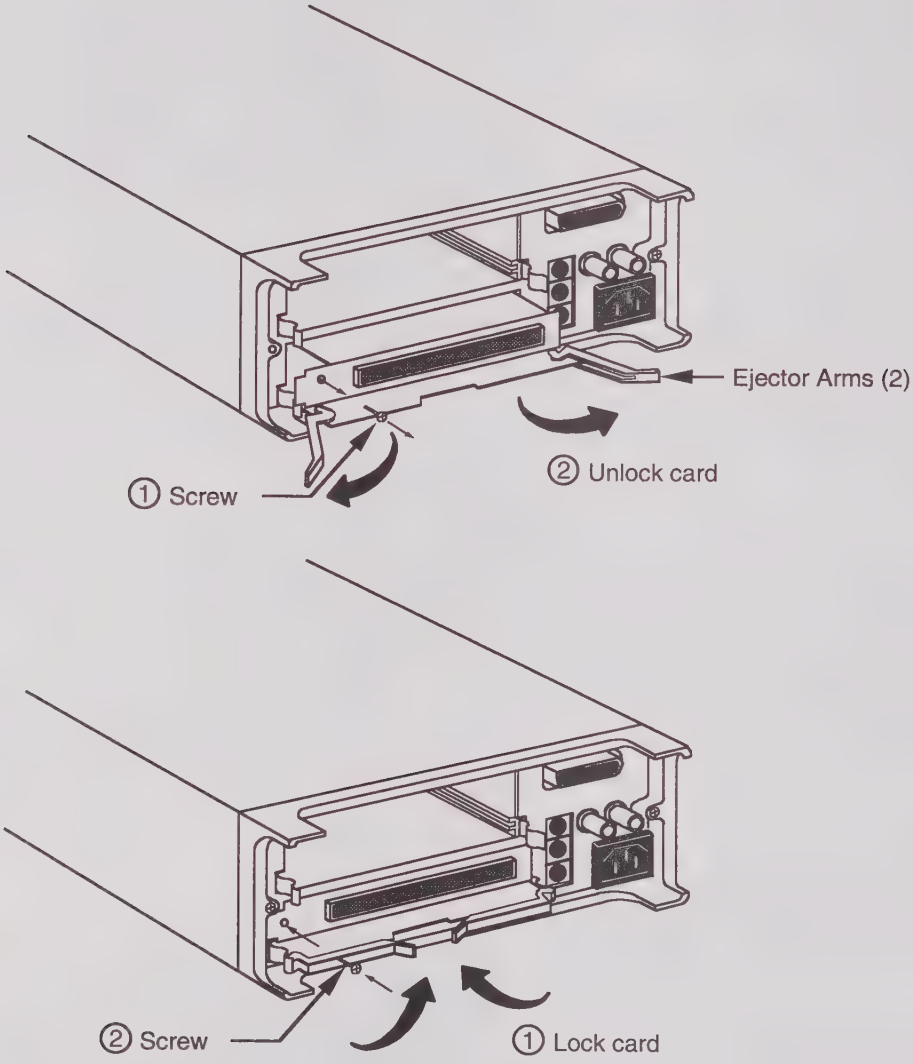


Figure 3-18
Model 7011-C card installation in Model 7001

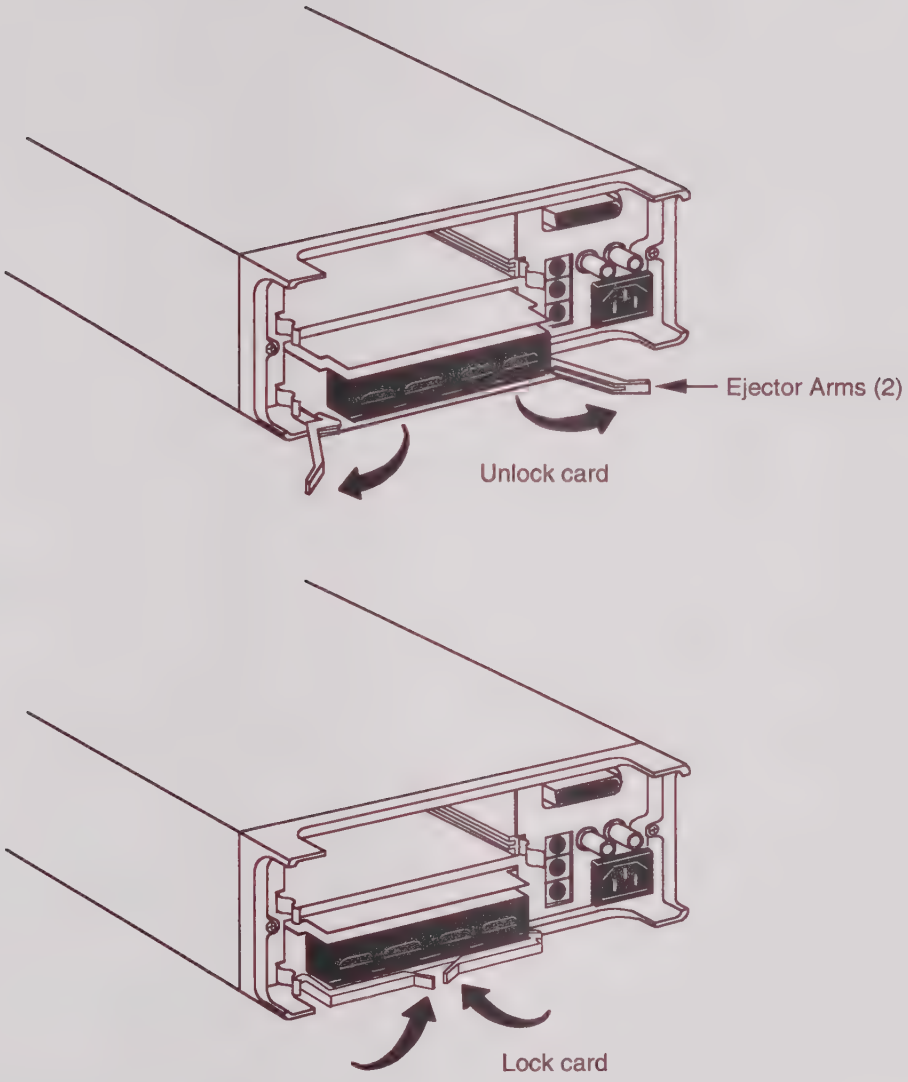


Figure 3-19
7011-S card installation in Model 7001

4
Operation

4.1 Introduction

The information in this section is formatted as follows:

4.2 **Power limits:** Summarizes the maximum power limits of the Model 7011 multiplexer card assembly.

4.3 **Mainframe control of multiplexer card:** Summarizes programming steps to control the multiplexer card from the Model 7001 Switch System mainframe.

4.4 **Multiplexer switching examples:** Provides some typical applications for using the Model 7011.

4.5 **Measurement considerations:** Reviews a number of considerations when using the Model 7011 to make measurements.

4.2 Power limits

CAUTION

To prevent damage to the card, do not exceed the maximum signal level specifications of the card.

Maximum signal levels

To prevent overheating or damage to the relays, never exceed the following maximum signal levels:

DC signals: 110V between any two pins (terminals), 1A switched, 30VA (resistive load).

AC signals: 125V rms or 175V AC peak between any two pins (terminals), 1A switched, 60VA (resistive load)

4.3 Mainframe control of matrix card

The following information pertains to the Model 7011 multiplexer card. It assumes that you are familiar with the operation of the Model 7001 mainframe.

If you are not familiar with the operation of the mainframe, it is recommended that you proceed to Getting Started (Section 3) of the Model 7001 Instruction Manual after reading the following information.

4.3.1 Channel assignments

The Model 7001 has a channel status display (Figure 4-1) that provides the real-time state of each available channel. The left portion of the display is for slot 1 (Card 1), and the right portion is for slot 2 (Card 2).

Multiplexer organization of the channel status display for each slot is shown in Figure 4-2. The card contains 40 channels and is made up of four banks (Bank A, B, C, and D) of 10 multiplexer inputs as shown in the illustration.

To control the multiplexer (mux) card from the mainframe, each multiplexer input must have a unique CHANNEL assignment which includes the slot number that the card is installed in. The CHANNEL assignments for the multiplexer card are provided in Figure 4-3. Each CHANNEL assignment is made up of the slot designator (1 or 2) and the multiplexer channel. To be consistent with Model 7001 operation, the slot designator and mux input are separated by exclamation points (!). Some examples of CHANNEL assignments are as follows:

CHANNEL 1!1 = Slot 1, Channel 1 (Input 1 of Bank A)
CHANNEL 1!40 = Slot 1, Channel 40 (Input 10 of Bank D)
CHANNEL 2!23 = Slot 2, Channel 23 (Input 3 of Bank C)
CHANNEL 2!36 = Slot 2, Input 36 (Input 6 of Bank D)

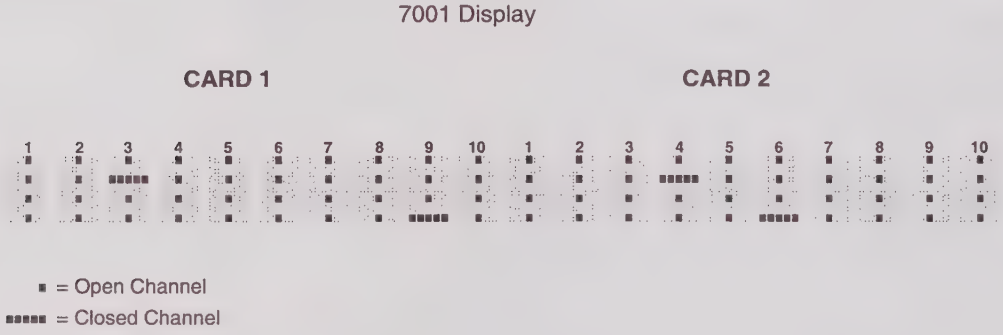


Figure 4-1
Channel status display

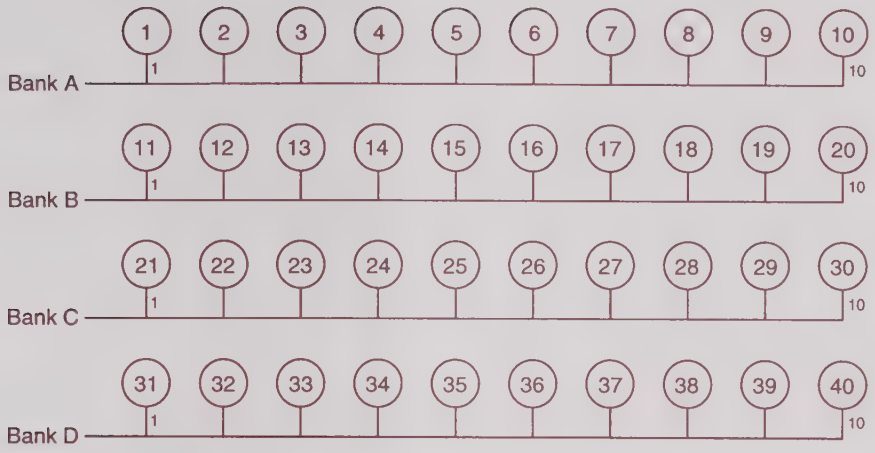


Figure 4-2
Display organization for multiplexer channels

A. Slot 1 (Card 1)

1	2	3	4	5	6	7	8	9	10
1!1	1!2	1!3	1!4	1!5	1!6	1!7	1!8	1!9	1!10
1!11	1!12	1!13	1!14	1!15	1!16	1!17	1!18	1!19	1!20
1!21	1!22	1!23	1!24	1!25	1!26	1!27	1!28	1!29	1!30
1!31	1!32	1!33	1!34	1!35	1!36	1!37	1!38	1!39	1!40

B. Slot 2 (Card 2)

1	2	3	4	5	6	7	8	9	10
2!1	2!2	2!3	2!4	2!5	2!6	2!7	2!8	2!9	2!10
2!11	2!12	2!13	2!14	2!15	2!16	2!17	2!18	2!19	2!20
2!21	2!22	2!23	2!24	2!25	2!26	2!27	2!28	2!29	2!30
2!31	2!32	2!33	2!34	2!35	2!36	2!37	2!38	2!39	2!40

Examples : 1!18 = Slot 1, Channel 18 (Input 8, Bank B)
2!36 = Slot 2, Channel 36 (Input 6, Bank D)

Figure 4-3
Model 7011 programming channel assignments

4.3.2 Front panel control

Closing and opening channels

A multiplexer channel is closed from the front panel by simply keying in the CHANNEL assignment and pressing CLOSE. For example, to close channel 36 (Input 6 of Bank D) of a multiplexer card installed in slot 2, key in the following channel list and press CLOSE:

SELECT CHANNELS 2!36

The above closed channel can be opened by pressing OPEN or OPEN ALL. The OPEN key opens only the channels specified in the channel list, and OPEN ALL opens all channels.

The following display is an example of a channel list that consists of several channels:

SELECT CHANNELS 2!1, 2!3, 2!22-2!25

Notice that channel entries are separated by commas (,). A comma is inserted by pressing ENTER or the right cursor key ▷). The channel range is specified by using the hyphen (-) key to separate the range limits. Pressing CLOSE will close all the channels specified in the channel list. Pressing OPEN (or OPEN ALL) will open the channels.

Scanning channels

Multiplexer channels are scanned by creating a scan list and configuring the Model 7001 to perform a scan. The scan list is created in the same manner as a channel list (see Closing and Opening Channels). However, the scan list is specified from the "SCAN CHANNEL" display mode.)The SCAN LIST key toggles between the channel list and the scan list.) The following shows an example of a scan list:

SCAN CHANNELS 2!1, 2!3, 2!21-2!25

When a scan is performed, the channels specified in the scan list will be scanned in the order that they are presented in the scan list.

A manual scan can be performed by using the RESET default conditions of the Model 7001. RESET is selected from the SAVESETUP menu of the main MENU. When RESET is performed, the mainframe is configured for an infinite number of manual scans. The first press of STEP takes the mainframe out of the idle state. The next press of STEP will close the first channel specified in the scan list. Each subsequent press of STEP will select the next channel in the scan list.

4.3.3 IEEE-488 bus operation

Bus operation is demonstrated using HP BASIC 4.0. The programming statements assume that the primary address of the mainframe is 07.

Closing and opening channels

The following SCPI commands are used to close and open channels:

:CLOSe <list>
:OPEN <list>|ALL

The following statement closes channels 1!1, and 1!3 through 1!11:

OUTPUT 707; ":clos (@ 1!1, 1!3:1!11)"

Notice that the colon (:) is used to separate the range limits.

Either of the following statements will open channels 1!1, and 1!3 through 1!11:

OUTPUT 707; ":open (@ 1!1, 1!3:1!11)"
OUTPUT 707; ":open all"

Scanning channels

There are many commands associated with scanning. However, it is possible to configure a scan using as little as four commands. These commands are listed as follows:

*RST
:TRIGger:SEQuence:COUNt:AUTo ON"
:ROUTe:SCAN <list>
:INIT

The first command resets the mainframe to a default scan configuration. The second command automatically sets the channel count to the number of channels in the Scan List, the third command defines the Scan List and the fourth command takes the Model 7001 out of the idle state.

The following program will perform a single scan through all 40 channels of a multiplexer card installed in slot 1:

```
10  OUTPUT 707; "*RST"
20  OUTPUT 707; ":trig:seq:coun:auto on"
30  OUTPUT 707; ":scan (@ 1!1:1!40)"
40  OUTPUT 707; ":init"
50  END
```

Line 10 Selects a default configuration for the scan.
Line 20 Sets channel count to the scan-list-length.
Line 30 Defines the scan list.
Line 40 Take the Model 7001 out of the idle state. The scan is configured to start as soon as this command is executed.

When the above program is run, the scan will be completed in approximately 240 milliseconds (3msec delay for each relay close and a 3msec delay for each open), which is too fast to view from the front panel. An additional relay delay can be added to the program to slow down the scan for viewing. The program is modified by adding line 25 to slow down the scan. Also, Line 5 is added to the beginning of the program to ensure that all channels are open before the scan is started.

```
5   OUTPUT 707; ":open all"
10  OUTPUT 707; "*RST"
20  OUTPUT 707; ":trig:seq:coun:auto on"
25  OUTPUT 707; ":trig:del 0.25"
30  OUTPUT 707; ":scan (@ 1!1:1!40)"
40  OUTPUT 707; ":INIT"
50  END
```

Line 5 Opens all channels.
Line 25 Sets a 1/4 second delay after each channel closes.

4.4 Multiplexer switching examples

This paragraph presents some typical applications for the Model 7011. These include resistor testing, transistor testing, and resistivity testing, which shows how to use the Model 7011 with a matrix card (Model 7012).

4.4.1 Resistor testing

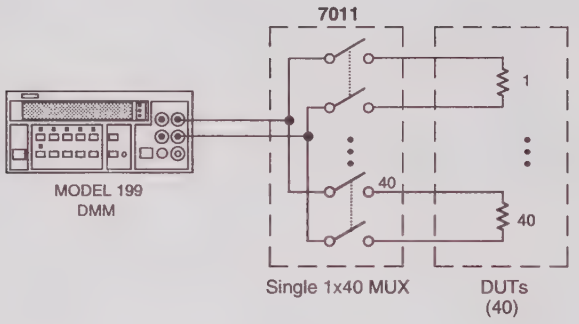
The Model 7011 can be used to test a large number of resistors using only one test instrument or group of instruments. Such tests include two-wire and four-wire resistance measurements using a DMM, and low-resistance measurements using a current source and sensitive digital voltmeter, as discussed in the following paragraphs.

Two-wire resistance tests

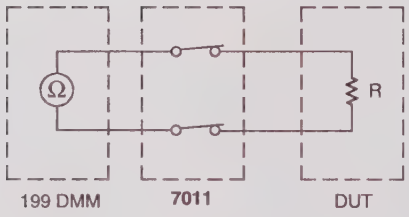
Figure 4-4 shows a typical test setup for making two-wire resistance measurements. The Model 7011 card provides the switching function, while the resistance measurements are made by a Model 199 DMM. Since only two-pole switching is required for this application, one Model 7011 card can be used to switch up to 40 resistors (additional multiplexer banks can be added, if desired, by adding more cards).

Accuracy of measurements can be optimized by minimizing stray resistance.

Make connecting wires as short as possible to minimize path resistance. Another technique is to short one of the multiplexer inputs, close the shorted channel and then enable the DMM zero feature to cancel path resistance. Leave zero enabled for the entire test.



A. Test Configuration



B. Simplified Equivalent Circuit

Figure 4-4
2-wire resistance testing

Four-wire resistance tests

More precise measurements over a wider range of system and DUT conditions can be obtained by using the four-wire measurement scheme shown in Figure 4-5. Here, separate sense leads from the Model 196 DMM are routed through the multiplexer to the resistor under test. The extra set of sense leads minimizes the effects of voltage drops across the test leads. Note, however, that an extra two poles of switching are required for each resistor tested. For this reason, only 20 resistors per card can be tested using this configuration.

The Model 7011 can be configured for 20 channels of 4-pole operation by isolating Banks A and B from Banks C and D, and by programming the Model 7001 mainframe for 4-pole mode. The resulting paired channels are shown in Table 4-1.

Table 4-1
Paired Channels in 4-pole Operation

7001 CHANNEL assignment	Channel pair in 4-pole	Connection designations
1	1 and 21	Bank A, In 1 and Bank C, In 1
2	2 and 22	Bank A, In 2 and Bank C, In 2
3	3 and 23	Bank A, In 3 and Bank C, In 3
4	4 and 24	Bank A, In 4 and Bank C, In 4
5	5 and 25	Bank A, In 5 and Bank C, In 5
6	6 and 26	Bank A, In 6 and Bank C, In 6
7	7 and 27	Bank A, In 7 and Bank C, In 7
8	8 and 28	Bank A, In 8 and Bank C, In 8
9	9 and 29	Bank A, In 9 and Bank C, In 9
10	10 and 30	Bank A, In 10 and Bank C, In 10
11	11 and 31	Bank B, In 1 and Bank D, In 1
12	12 and 32	Bank B, In 2 and Bank D, In 2
13	13 and 33	Bank B, In 3 and Bank D, In 3
14	14 and 34	Bank B, In 4 and Bank D, In 4
15	15 and 35	Bank B, In 5 and Bank D, In 5
16	16 and 36	Bank B, In 6 and Bank D, In 6
17	17 and 37	Bank B, In 7 and Bank D, In 7
18	18 and 38	Bank B, In 8 and Bank D, In 8
19	19 and 39	Bank B, In 9 and Bank D, In 9
20	20 and 40	Bank B, In 10 and Bank D, In 10

Bank jumper removal is described in paragraph 3.3.1. To configure the connector card for 4-pole operation, only remove the jumpers between Banks C and D (W102 and W103).

Selecting 4-pole operation for a Model 7001 card slot is discussed in Section 4 of the Model 7001 Instruction Manual. After the 4-pole mode is selected, the Model 7001 mainframe will display just 20 channels for the chosen card slot. Each closed channel will also close its paired channel on the card.

Although the four-wire connection scheme minimizes problems caused by voltage drops, there is one other potentially troublesome area associated with low resistance measurements: thermal EMFs caused by the relay contacts. In order to compensate for thermal EMFs, the offset-compensated ohms feature of the Model 196 DMM should be used. To use this feature, short the HI and LO terminals of one of the bank inputs, then close the relay. Enable zero on the Model 196, then select offset-compensated ohms.

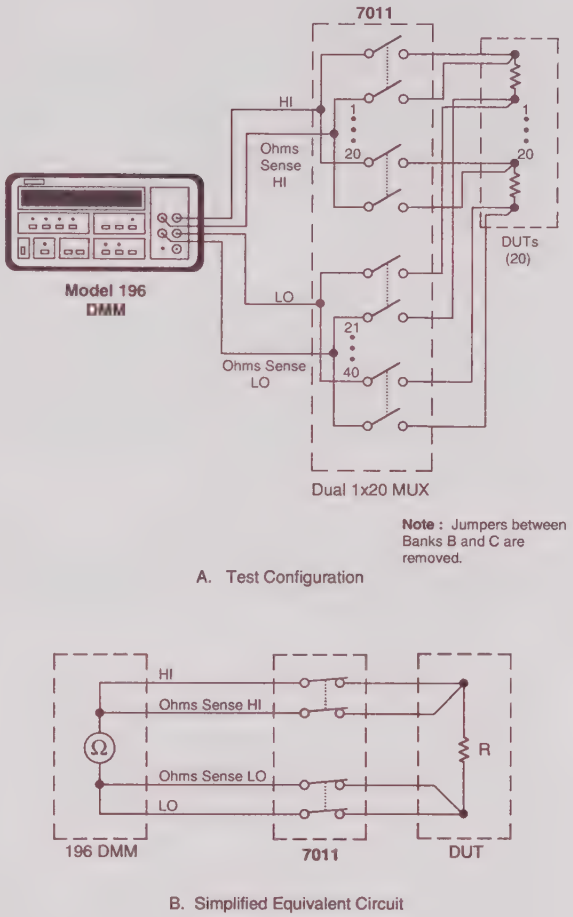


Figure 4-5
Four-wire resistance testing

Low-level resistance measurements

Many times, it is necessary to make resistance measurements with either lower voltage sensitivity or higher currents than are available with ordinary DMMs. Examples of cases where low-level resistance measurements may be necessary include the testing of PC board traces, contacts, bus bars, and low resistance shunts.

Figure 4-6 shows a typical test configuration for a switching system capable of testing a number of low resistance devices. The Model 220 Current Source forces current through the device under test, while the Model 182 Sensitive Digital Voltmeter measures the resulting voltage across the device.

Since low voltage levels are being measured, thermal EMF offsets generated by relay and connector contacts will have a detrimental effect on measurement accuracy unless steps are taken to avoid them (the Model 7011 has been designed to keep relay EMF at a minimal level.). Thermal EMF effects can be virtually eliminated by taking two voltage measurements, E_1 and E_2, the first with the current, I, flowing in one direction, and the second with a current, I, of the same magnitude flowing in the opposite direction. The resistance can then be calculated as follows:

$$R = \frac{E_2 - E_1}{2I}$$

Note that simply reversing the current source polarity will result in a 2X accuracy specification change. To avoid this problem, matrix switching could be added to the test system to reverse the current. See paragraph 4.4.3.

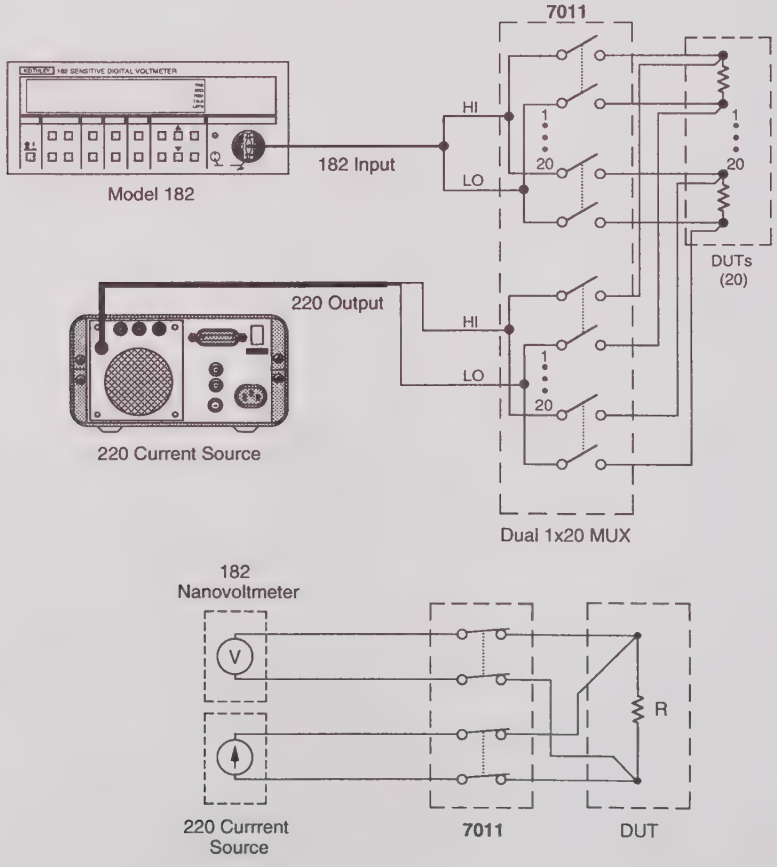


Figure 4-6
Low resistance testing

4.4.2 Transistor testing

Typical transistor tests that can be performed with the aid of the Model 7011 include current gain tests, leakage tests, as well as tests to determine the common-emitter characteristics of the device. The following paragraphs discuss these tests and give typical equipment configurations for the tests.

Current gain tests

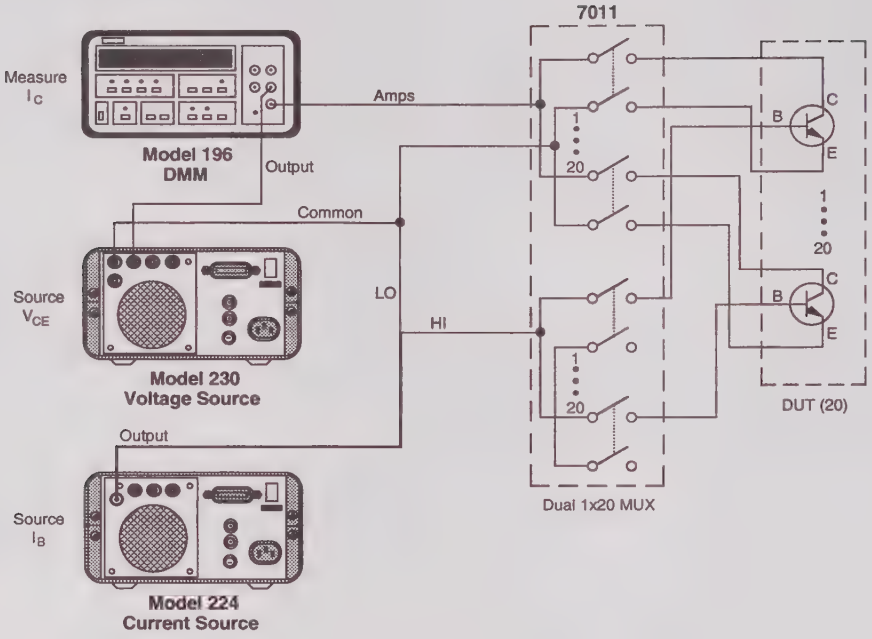
The DC or static common-emitter current gain of a transistor can be determined by biasing the transistor for a specific value of base current, I_B, and then measuring the collector current, I_C. The DC common-emitter current gain, β, of the transistor is then determined as follows:

$$\beta = \frac{I_C}{I_B}$$

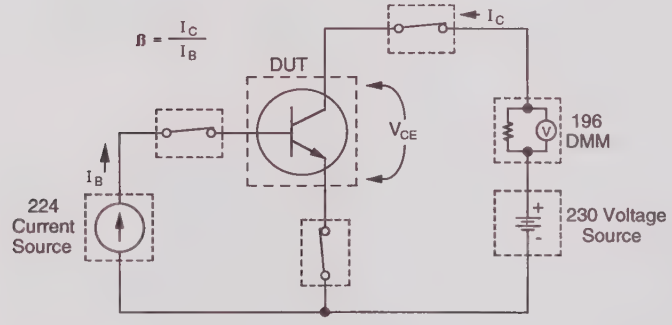
Figure 4-7 shows the test configuration and equivalent circuit for the current gain test. The Model 224 Current Source is used to source the base current, I_B. The Model 230 Voltage Source supplies the collector-emitter voltage, V_{CE}, and the collector current, I_C, is measured by the Model 196 DMM. Switching among the transistors being tested is, of course, performed by the Model 7011 multiplexer card.

In order to perform the current gain test, the voltage source is first set to the desired value of V_{CE}. The current source is then set to a base current value that will result in the desired value of I_C as measured by the DMM. The current gain can then be calculated as outlined above.

In order to reduce errors caused by voltage burden, use a higher current range on the Model 196 DMM. Doing so will result in the loss of one or two decades of resolution, but 3 ½ or 4 ½-digit resolution will probably be adequate for most situations.



A. Test Configuration



B. Simplified Equivalent Circuit

Figure 4-7
Configuration for current gain and common-emitter test

Common-emitter characteristic tests

Common-emitter characteristics are determined by setting the base current, I_B, to specific values. At each I_B value, the collector-emitter voltage, V_{CE}, is swept across the desired range at specific intervals, and the collector current, I_C, is then measured. When the data are plotted, the result is the familiar family of common-emitter curves (Figure 4-8).

The same test configuration that is used for current gain tests can be used for measuring common-emitter characteristics. The Model 224 is used to set the base current, I_B, to the desired values. The Model 230 Voltage Source provides the collector-emitter voltage, V_{CE}, and the Model 196 DMM measures the collector current, I_C.

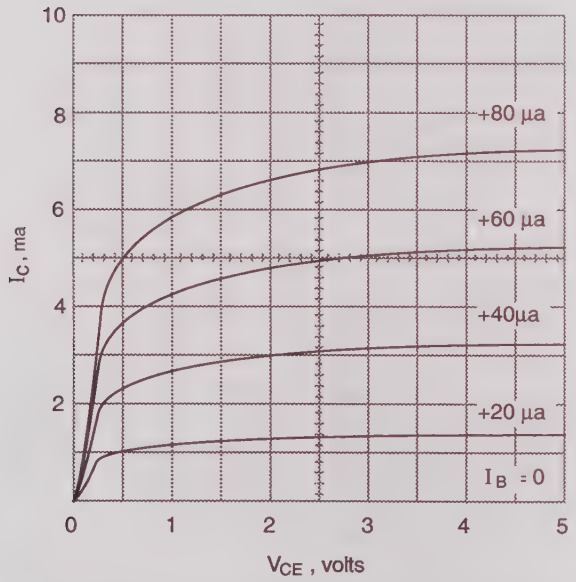


Figure 4-8
Typical common-emitter characteristics

4.4.3 Testing with matrix cards

The Model 7011 can be added to a matrix switching system to enhance the test capabilities of that system. The following paragraphs discuss an overall multiplexer/matrix switching system and also briefly outline a typical test that can be made with such a system.

Multiplexer and matrix card connections

Figure 4-9 shows a typical system using Model 7012 and 7011 cards together. In this instance, the multiplexer card is configured as four 1 × 10 multiplexers. Note that rows of the matrix card are connected to the banks of the multiplexer card through the analog backplane of the mainframe; no external wiring is necessary to connect the two cards together.

In this application, the DUTs are connected to the bank inputs on the multiplexer card, allowing a large number of DUTs to be switched through the matrix card. Also, the instruments are connected to the columns on the matrix card. This particular configuration is best suited for applications requiring a large number of DUTs to be connected to several instruments. In other cases, the test configuration may call for a large number of instruments and few DUTs. In those situations, the instruments would be connected to the multiplexer inputs, and the DUTs would be connected to the columns.

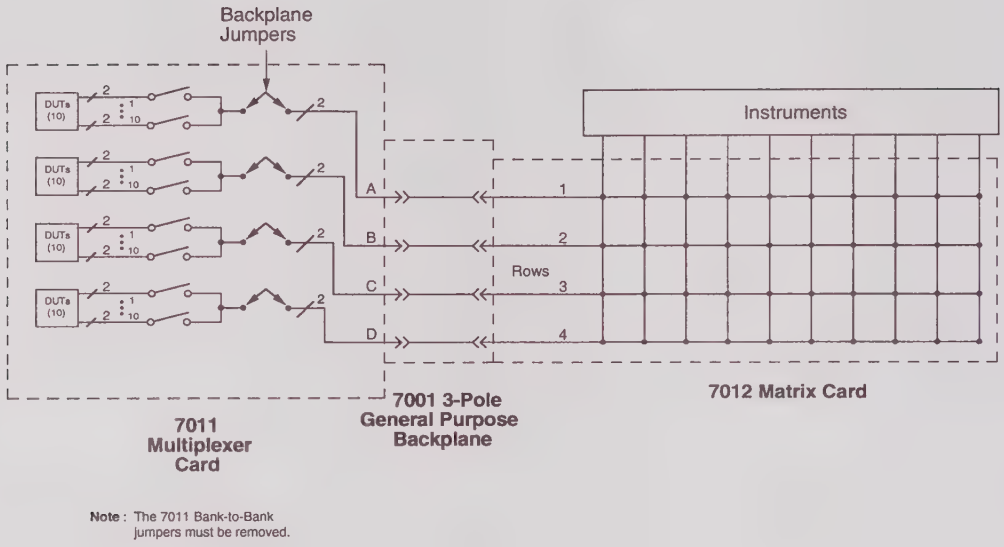


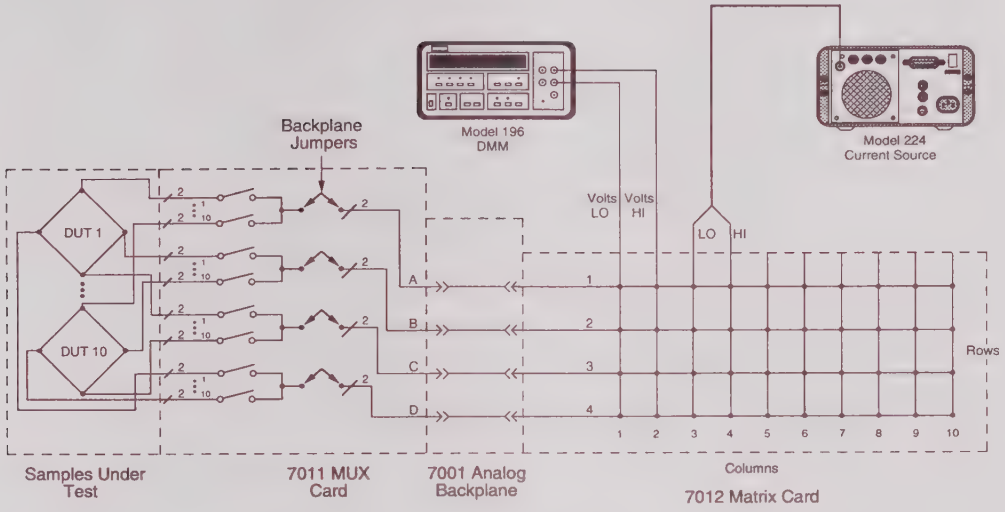
Figure 4-9
Connecting multiplexer and matrix cards together

Resistivity tests

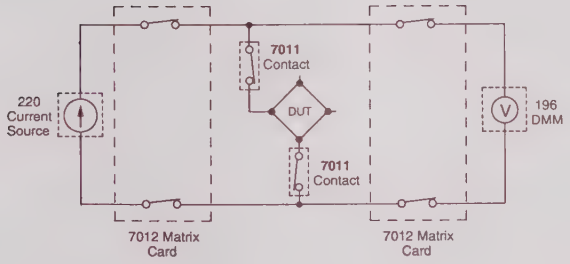
The general test configuration shown in Figure 4-10 can be used to perform resistivity tests on semiconductors. Such tests can yield important information such as doping concentration.

As shown in Figure 4-10, the Model 7011 switches ten samples for the test. The Model 7012 Matrix card allows any device test node to be connected to any instrument terminal. The Model 220 Current Source forces a current through the DUT, and the Model 196 DMM measures the voltage across the device. In order to minimize errors caused by sample loading, the Model 196 should be used on the 300mV or 3V ranges. Also, resistance values should be 1MΩ or less.

In order to perform the tests, a current (from the Model 220) is applied to two terminals, and the voltage is measured (by the Model 196) across the two opposite terminals. A total of eight such measurements are required, as shown in Figure 4-11.



A. Connections



B. Simplified Equivalent Circuit (One measurement leg shown)

Figure 4-10
Resistivity test configuration

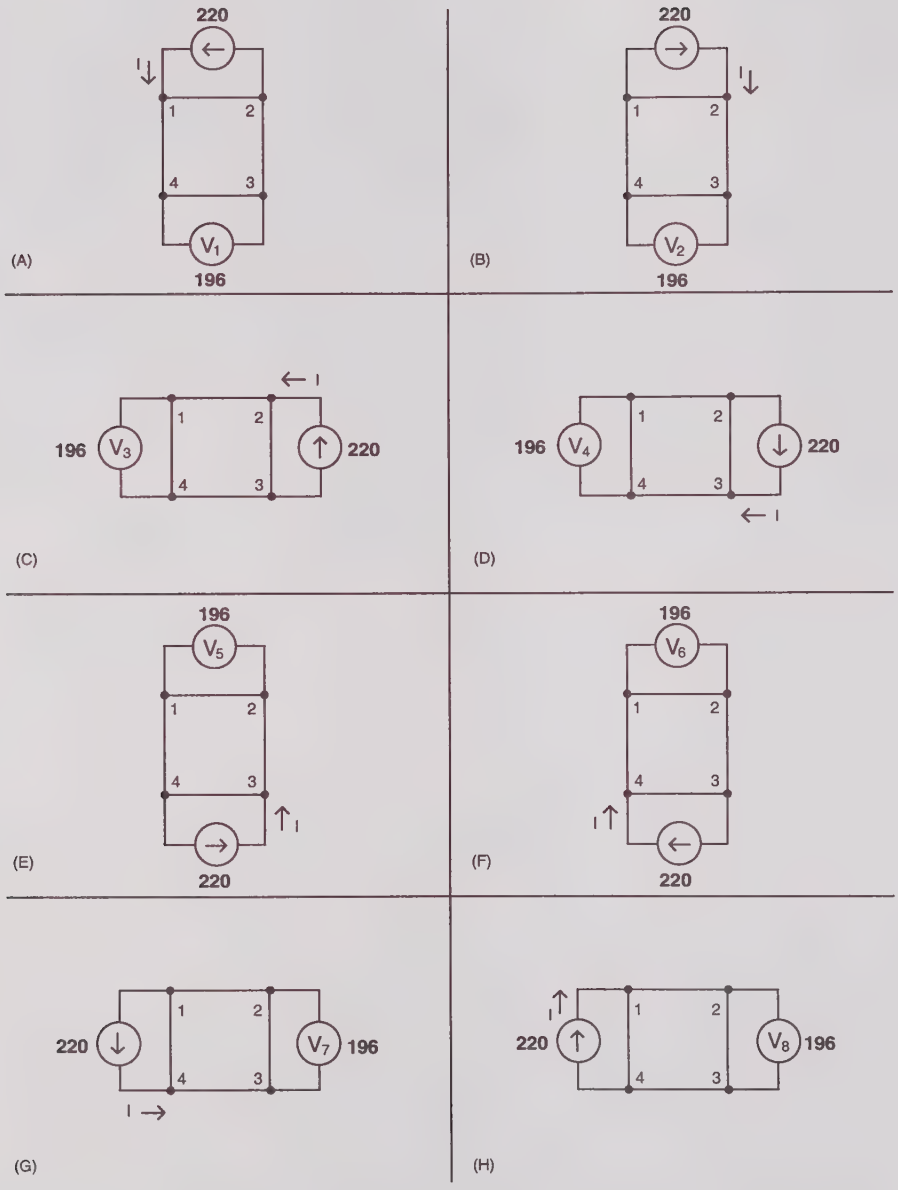


Figure 4-11
Measurement required for resistivity test

Once the measurements have been taken, the resistivity can be calculated. Two values of resistivity, A and B, are initially computed as follows:

$$\sigma_A = \frac{1.1331 f_A t_S (V_2 + V_4 - V_1 - V_3)}{I}$$

$$\sigma_B = \frac{1.1331 f_B t_S (V_6 + V_8 - V_5 - V_7)}{I}$$

Where:

σ_A and σ_B are the resistivities in Ω-cm,

t_S is the sample thickness in cm,

V_1 through V_8 are the voltages measured by the Model 196,

I is the current through the sample in amperes,

f_A and f_B are geometrical factors based on sample symmetry ($f_A = f_B = 1$) for perfect symmetry.

Once σ_A and σ_B are known, the average resistivity, σ_{AVG}, can be determined as follows:

$$\sigma_{AVG} = \frac{\sigma_A - \sigma_B}{2}$$

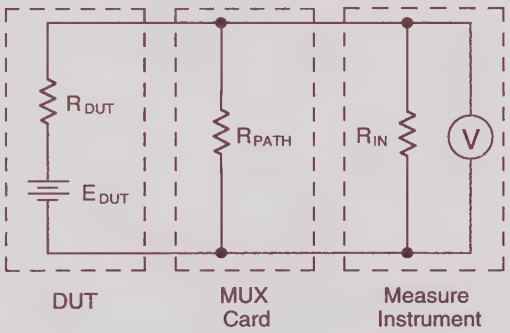
4.5 Measurement considerations

Many measurements made with the Model 7011 are subject to various effects that can seriously affect low-level measurement accuracy. The following paragraphs discuss these effects and ways to minimize them.

4.5.1 Path isolation

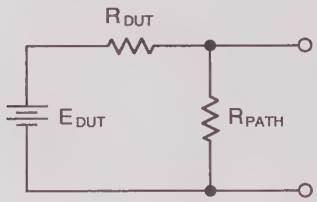
The path isolation is simply the equivalent impedance between any two test paths in a measurement system. Ideally, the path isolation should be infinite, but the actual resistance and distributed capacitance of cables and connectors results in less than infinite path isolation values for these devices.

Path isolation resistance forms a signal path that is in parallel with the equivalent resistance of the DUT, as shown in Figure 4-12. For low-to-medium device resistance values, path isolation resistance is seldom a consideration; however, it can seriously degrade measurement accuracy when testing high-impedance devices. The voltage measured across such a device, for example, can be substantially attenuated by the voltage divider action of the device source resistance and path isolation resistance, as shown in Figure 4-13. Also, leakage currents can be generated through these resistances by voltage sources in the system.



R_{DUT} = Source Resistance of DUT
E_{DUT} = Source EMF of DUT
R_{PATH} = Path Isolation Resistance
R_{IN} = Input Resistance of Measuring Instrument

Figure 4-12
Path isolation resistance



$$E_{OUT} = \frac{E_{DUT}\ R_{PATH}}{R_{DUT} + R_{PATH}}$$

Figure 4-13
Voltage attenuation by path isolation resistance

Any differential isolation capacitance affects DC measurement settling time as well as AC measurement accuracy. Thus, it is often important that such capacitance be kept as low as possible. Although the distributed capacitance of the matrix card is generally fixed by design, there is one area where you do have control over the capacitance in your system; the connecting cables. To minimize capacitance, keep all cables as short as possible

4.5.2 Magnetic fields

When a conductor cuts through magnetic lines of force, a very small current is generated. This phenomenon will frequently cause unwanted signals to occur in the test leads of a switching matrix system. If the conductor has sufficient length, even weak magnetic fields like those of the earth can create sufficient signals to affect low-level measurements.

Two ways to reduce these effects are: (1) reduce the lengths of the test leads, and (2) minimize the exposed circuit area. In extreme cases, magnetic shielding may be required. Special metal with high permeability at low flux densities (such as mu metal) is effective at reducing these effects.

Even when the conductor is stationary, magnetically-induced signals may still be a problem. Fields can be produced by various signals such as the AC power line voltage. Large inductors such as power transformers can generate substantial magnetic fields, so care must be taken to keep the switching and measuring circuits a good distance away from these potential noise sources.

At high current levels, even a single conductor can generate significant fields. These effects can be minimized by using twisted pairs, which will cancel out most of the resulting fields.

4.5.3 Radio frequency interference

RFI (Radio Frequency Interference) is a general term used to describe electromagnetic interference over a wide range of frequencies across the spectrum. Such RFI can be particularly troublesome at low signal levels, but is can also affect measurements at high levels if the problem is of sufficient severity.

RFI can be caused by steady-state sources such as radio or TV signals, or some types of electronic equipment (microprocessors, high speed digital circuits, etc.), or it can result from impulse sources, as in the case of arcing in high-voltage environments. In either case, the effect on the measurement can be considerable if enough of the unwanted signal is present.

RFI can be minimized in several ways. The most obvious method is to keep the equipment and signal leads as far away from the RFI source as possible. Shielding the switching card, signal leads, sources, and measuring instruments will often reduce RFI to an acceptable level. In extreme cases, a specially-constructed screen room may be required to sufficiently attenuate the troublesome signal.

Many instruments incorporate internal filtering that may help to reduce RFI effects in some situations. In some cases, additional external filtering may also be required. Keep in mind, however, that filtering may have detrimental effects on the desired signal.

4.5.4 Ground loops

When two or more instruments are connected together, care must be taken to avoid unwanted signals caused by ground loops. Ground loops usually occur when sensitive instrumentation is connected to other instrumentation with more than one signal return path such as power line ground. As shown in Figure 4-14, the resulting ground loop causes current to flow through the instrument LO signal leads and then back through power line ground. This circulating current develops a small but undesirable voltage between the LO terminals of the two instruments. This voltage will be added to the source voltage, affecting the accuracy of the measurement.

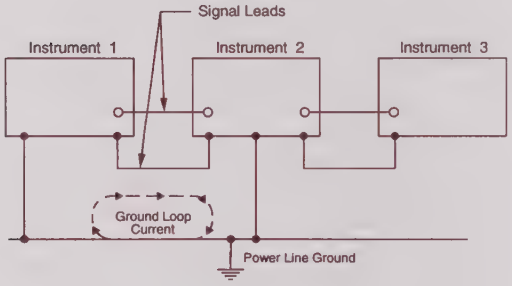


Figure 4-14
Power line ground loops

Figure 4-15 shows how to connect several instruments together to eliminate this type of ground loop problem. Here, only one instrument is connected to power line ground.

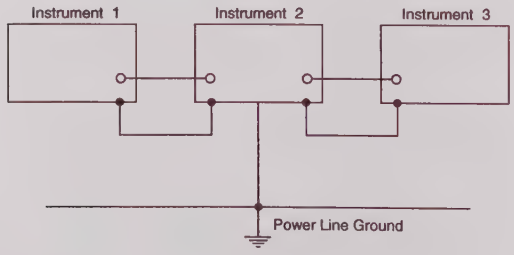


Figure 4-15
Eliminating ground loops

Ground loops are not normally a problem with instruments having isolated LO terminals. However, all instruments in the test setup may not be designed in this manner. When in doubt, consult the manual for all instrumentation in the test setup.

4.5.5 Keeping connectors clean

As is the case with any high-resistance device, the integrity of connectors can be damaged if they are not handled properly. If connector insulation becomes contaminated, the insulation resistance will be substantially reduced, affecting high-impedance measurement paths.

Oils and salts from the skin can contaminate connector insulators, reducing their resistance. Also, contaminants present in the air can be deposited on the insulator surface. To avoid these problems, never touch the connector insulating material. In addition, the multiplexer card should be used only in clean, dry environments to avoid contamination.

If the connector insulators should become contaminated, either by inadvertent touching, or from air-borne deposits, they can be cleaned with a cotton swab dipped in clean methanol. After thoroughly cleaning, they should be allowed to dry for several hours in a low-humidity environment before use, or they can be dried more quickly using dry nitrogen.

4.5.6 AC frequency response

The AC frequency response of the Model 7011 is important in test systems that switch AC signals. Refer to the specifications at the front of this manual.

5

Service Information

WARNING

The information in this section is intended only for qualified service personnel. Some of the procedures may expose you to hazardous voltages that could result in personal injury or death. Do not attempt to perform these procedures unless you are qualified to do so.

5.1 Introduction

This section contains information necessary to service the Model 7011 multiplexer card and is arranged as follows:

5.2 **Handling and cleaning precautions:** Discusses handling precautions and methods to clean the card should it become contaminated.

5.3 **Performance verification:** Covers the procedures necessary to determine if the card meets stated specifications.

5.4 **Special handling of static-sensitive devices:** Reviews precautions necessary when handling static-sensitive devices.

5.5 **Principles of operation:** Briefly discusses circuit operation.

5.6 **Troubleshooting:** Presents some troubleshooting tips for the Model 7011 including relay replacement precautions.

5.2 Handling and cleaning precautions

Because of the high-impedance areas on the Model 7011, care should be taken when handling or servicing the card to prevent possible contamination. The following precautions should be taken when servicing the card.

Handle the card only by the edges and shields. Do not touch any board surfaces or components not associated with the repair. Do not touch areas adjacent to electrical contacts. When servicing the card, wear clean cotton gloves.

Do not store or operate the card in an environment where dust could settle on the circuit board. Use dry nitrogen gas to clean dust off the board if necessary.

Should it become necessary to use solder on the circuit board, use an OA-based (organic activated) flux. Remove the flux from the work areas when the repair has been completed. Use pure water along with clean cotton swabs or a clean soft brush to remove the flux. Take care not to spread the flux to other areas of the circuit

board. Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.

After cleaning, the card should be placed in a 50°C low humidity environment for several hours before use.

5.3 Performance verification

The following paragraphs discuss performance verification procedures for the Model 7011, including path resistance, offset current, contact potential, and isolation.

With the Model 7011's backplane jumpers installed, the performance verification procedures must be performed with only one multiplexer card (the one being checked) installed in the Model 7001 mainframe. These conditions do not apply if the backplane jumpers are removed.

CAUTION

Contamination will degrade the performance of the card. To avoid contamination, always grasp the card by the side edges. Do not touch the connectors, and do not touch the board surfaces or components. On plugs and receptacles, do not touch areas adjacent to the electrical contacts.

NOTE

Failure of any performance verification test may indicate that the multiplexer card is contaminated. See paragraph 5.2 to clean the card.

5.3.1 Environmental conditions

All verification measurements should be made at an ambient temperature between 18° and 28°C, and at a relative humidity of less than 70%.

5.3.2 Recommended equipment

Table 5-1 summarizes the equipment necessary for performance verification, along with an application for each unit.

Table 5-1
Verification equipment

Description	Model or part	Specifications	Applications
DMM	Keithley Model 196	300Ω; 0.01%	Path resistance
Electrometer w/voltage source	Keithley Model 617	10pA, 100pA; 1.6% 100V source; 0.2%	Offset current, path isolation
Sensitive Digital Voltmeter	Keithley Model 182	3mV; 60ppm	Contact potential
Triax cable (unterminated)	Keithley Model 7025	—	Offset current
Low thermal cable (unterminated)	Keithley Model 1484	—	Contact potential

5.3.3 Multiplexer card connections

The following information summarizes methods that can be used to connect test instrumentation to the two connector cards. Detailed connection information is provided in Section 3.

Model 7011-S — Instrumentation can simply be hard-wired directly to the screw terminals of the connector card. Jumper wires should be kept as short as possible.

Model 7011-C — One method to make instrument connections to the multiplexer card is by hard-wiring a 96-pin female DIN connector then mating it to the connector on the Model 7011-C. Input and output shorting connections can also be done at the connector. The connector in the Model 7011-KIT-R connection kit (see Table 3-2) can be used for this purpose. Pin identification for the connector is provided by Figure 3-8.

CAUTION

After making solder connections to a connector, remove solder flux as explained in paragraph 5.2. Failure to clean the solder connections could result in degraded performance preventing the card from passing verification tests.

Before pre-wiring any connectors or plugs, study the following test procedures to fully understand the connection requirements.

5.3.4 Channel resistance tests

Perform the following steps to verify that each contact of every relay is closing properly and that the resistance is within specification.

1. Turn the Model 7001 off if it is on.
2. Turn on the Model 196, and allow it to warm up for one hour before making measurements.
3. Connect all input terminals of Bank A together to form one common terminal, as shown in Figure 5-1.
4. Set the Model 196 to the 300Ω range and connect the four test leads to the OHMS and OHMS SENSE input jacks.
5. Short the four test leads together and zero the Model 196. Leave zero enabled for the entire test.
6. Connect OHMS HI and OHMS SENSE HI of the Model 196 to the common terminal (jumper on Bank A inputs). It is recommended that the physical connections be made at inputs 1 and 10 of Bank A, as shown in Figure 5-1.
7. Connect OHMS LO and OHMS SENSE LO to the HI (H) terminal of Bank A.
8. Install the Model 7011 in slot 1 (CARD 1) of the Model 7001.
9. Turn on the Model 7001 and program it to close Channel 1!1 (Bank A, Input 1). Verify that the resistance of this path is <1Ω.
10. Open Channel 1!1 and close Channel 1!2 (Bank A, Input 2). Verify that the resistance of this path is <1Ω.
11. Using the basic procedure in steps 9 and 10, check the resistance of Bank A HI (H) terminal paths for Inputs 3 through 10 (Channels 1!3 through 1!10).
12. Turn off the Model 7001 and move the OHMS LO and OHMS SENSE LO test leads to the LO (L) terminal of Bank A.
13. Repeat steps 9 through 11 to check the LO (L) terminal paths of Bank A (Channels 1!1 through 1!10).
14. Repeat the basic procedure in steps 1 through 13 for Banks B through D (Channels 1!11 through 1!40).

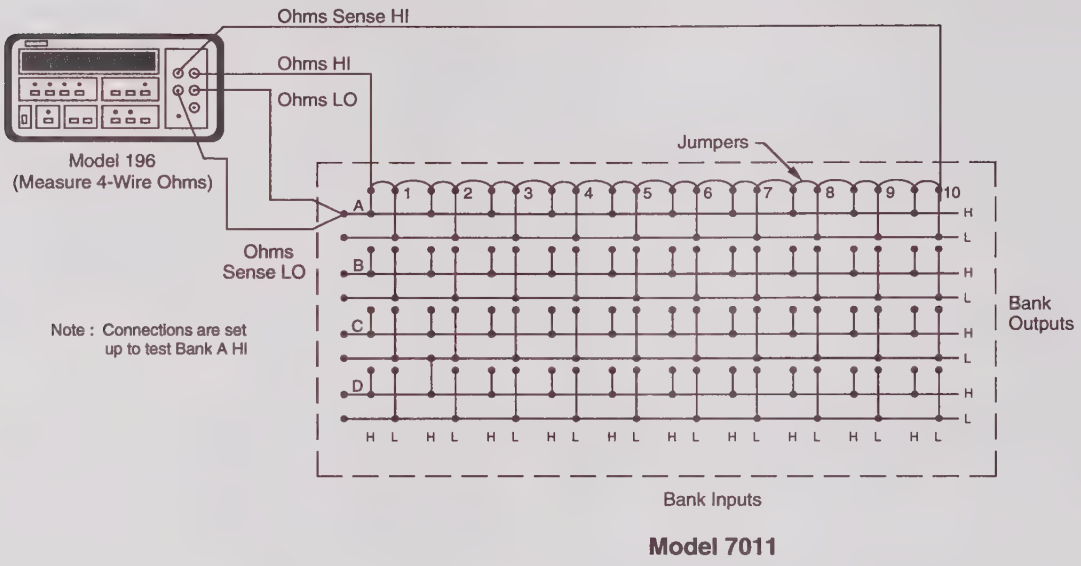


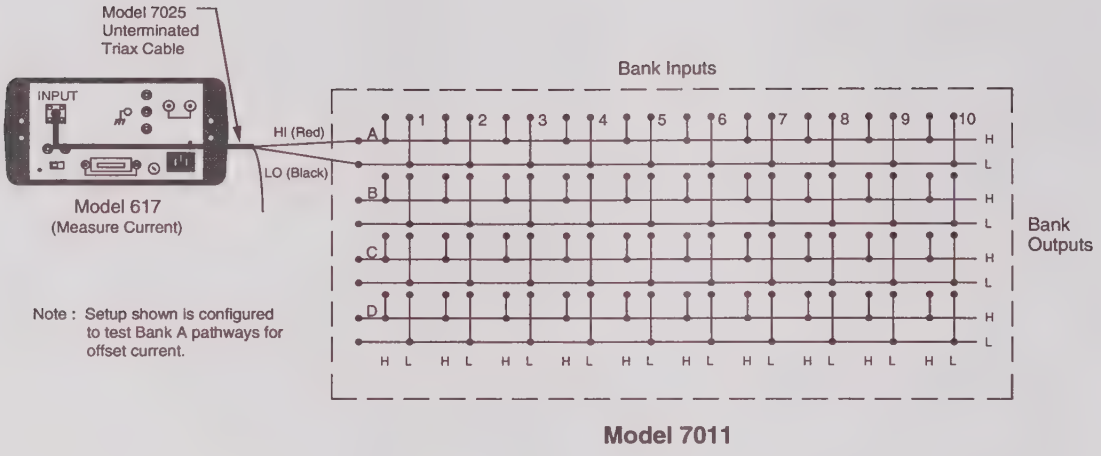
Figure 5-1
Path resistance test connections

5.3.5 Offset current tests

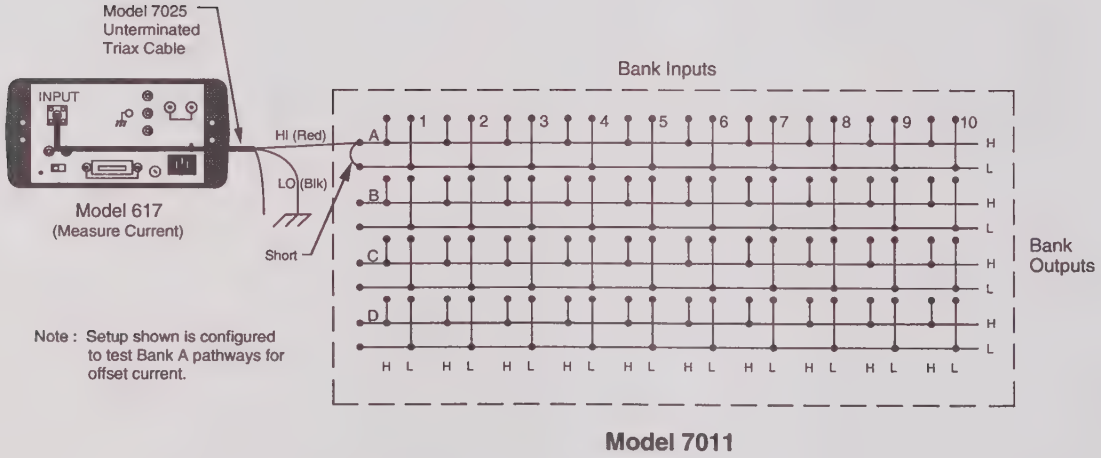
These tests check leakage current between HI (H) and LO (L) (differential offset current) and from HI (H) and LO (L) to chassis (common-mode offset current) of each pathway. In general, these tests are performed by simply measuring the leakage current with an electrometer. In the following procedure, the Model 617 is used to measure the leakage current. Test connections are shown in Figure 5-2.

Perform the following procedure to check offset current:

1. Turn the Model 7001 off if it is on, and remove any jumpers or wires connected to the multiplexer card.
2. Connect the triax cable to the Model 617, but do not connect it to the multiplexer card at this time.
3. Turn on the Model 617 and allow the unit to warm up for two hours before testing. After warm up, select the 200pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure. Also, be certain that V-Ω, GUARD is OFF and ground strap is connected to LO.
4. Connect the triax cable to Bank A HI and LO, as shown in Figure 5-2A.
5. Install the Model 7011 in slot 1 (CARD 1) of the Model 7001.
6. Turn on the Model 7001 and program the unit to close Channel 1!1 (Bank A, Input 1).
7. On the Model 617, disable zero check and allow the reading to settle. Verify that the reading is <100pA. This specification is the offset (leakage) current of the pathway.
8. Enable zero check on the Model 617 and open Channel 1!1 from the front panel of the Model 7001.
9. Repeat the basic procedure in steps 6 through 8 to check the rest of the pathways (Inputs 2 through 10) of Bank A (Channels 1!2 through 1!10).
10. Turn off the Model 7001 and change the electrometer connections to Bank B.
11. Repeat the basic procedure in steps 6 through 10 to check Bank B, Inputs 1 through 10 (Channels 1!11 through 1!20).
12. Repeat the basic procedure in steps 6 through 11 for Banks C and D (Channels 1!21 through 1!40).
13. Turn off the Model 7001 and change the electrometer connections, as shown in Figure 5-2B. Note that electrometer HI is connected to HI and LO of the Bank A output, which are jumpered together. Electrometer LO is connected to chassis.
14. Repeat steps 6 through 12 to check that the common mode offset current is <100pA.



A) Differential



B) Common-Mode

Figure 5-2
Differential offset current test connections

5.3.6 Contact potential tests

These tests check the EMF generated by each relay contact pair (H and L) for each pathway. The tests simply consist of using a sensitive digital voltmeter (Model 182) to measure the contact potential.

Perform the following procedure to check contact potential of each path:

1. Turn the Model 7001 off if it is on.
2. Place jumpers between Banks A-B, B-C, and C-D.
3. Turn on the Model 182 and allow the unit to warm up to achieve rated accuracy.
4. Place a short between HI to LO on each input (Channels 1-40).
5. Place a short between HI to LO on output Bank D (long enough to cut with wire cutters).
6. Connect the Model 182 input leads to HI and LO output Bank A using copper wires.
7. Install the Model 7011 in the Model 7001 slot 1, and turn the Model 7001 on.
8. Allow Models 7001, 7011 and 182 to warm up for two hours.
9. Select the 3mV range on the Model 182.
10. Press REL READING (on the Model 182) to null out internal offsets. Leave REL READING enabled for the entire procedure.
11. Turn the Model 7001 off. Remove the Model 7011 from slot 1. Cut the short on B and D output HI to LO.
12. Install the Model 7011 in the Model 7001 slot 1, and turn power on.
13. Wait 15 minutes.
14. Program the Model 7001 to close Channel 1!1.
15. After settling, verify that reading on the Model 182 is <500nV (for the Model 7011-S). This measurement represents the contact potential of the pathway.
16. From the Model 7001, open Channel 1!1.
17. Repeat steps 12 through 14 for all 40 channels.

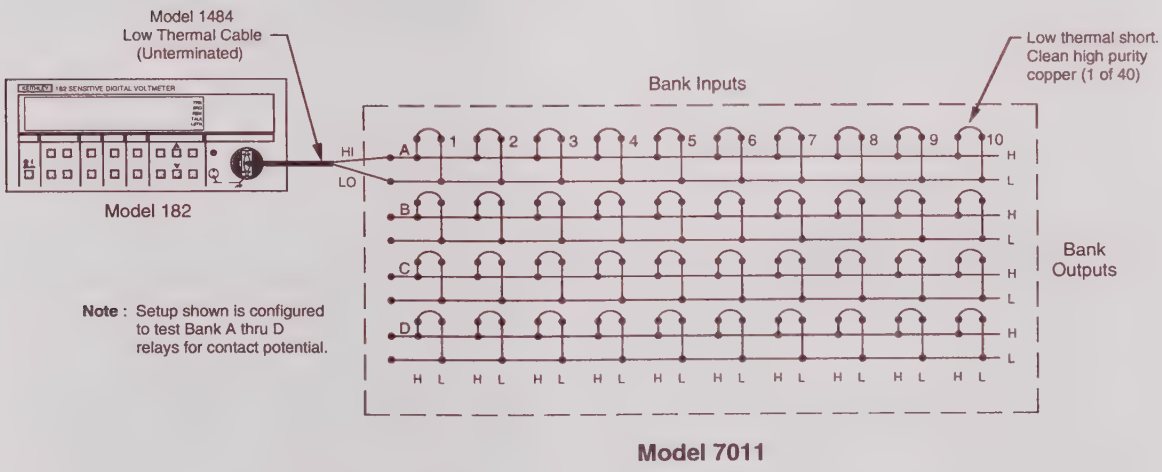


Figure 5-3
Contact potential test connections

5.3.7 Bank and channel-to-channel isolation tests

Bank isolation tests check the leakage resistance between adjacent banks. Channel-to-channel isolation tests check the leakage resistance between a Bank Output connection and a Bank Input connection with an adjacent Bank Input relay closed. In general, the tests are performed by applying a voltage (100V) across the leakage resistance and then measuring the current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as both a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and current levels and displays the resistive value.

Perform the following steps to check bank and channel-to-channel isolation:

1. Turn the Model 7001 off if it is on, and remove any jumpers or test leads connected to the multiplexer card.
2. Turn on the Model 617 and allow the unit to warm up for two hours before testing.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.
4. Connect the electrometer to the Model 7011, as shown in Figure 5-4.
5. Install the Model 7011 in slot 1 (CARD 1) of the Model 7001 and turn the mainframe on.
6. On the Model 617, select the 20pA range and release zero check.
7. On the Model 617, press SUPPRESS to cancel offset current, then enable zero check.

WARNING

The following steps use high voltage (100V). Be sure to remove power from the circuit before making connection changes.

8. On the Model 617, set the voltage source for +100V, and select the 20nA current range. Make sure the voltage source is in standby.
9. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
10. Program the Model 7001 to close Channels 1!1 and 1!12 (Bank A, Input 1 and Bank B, Input 2).

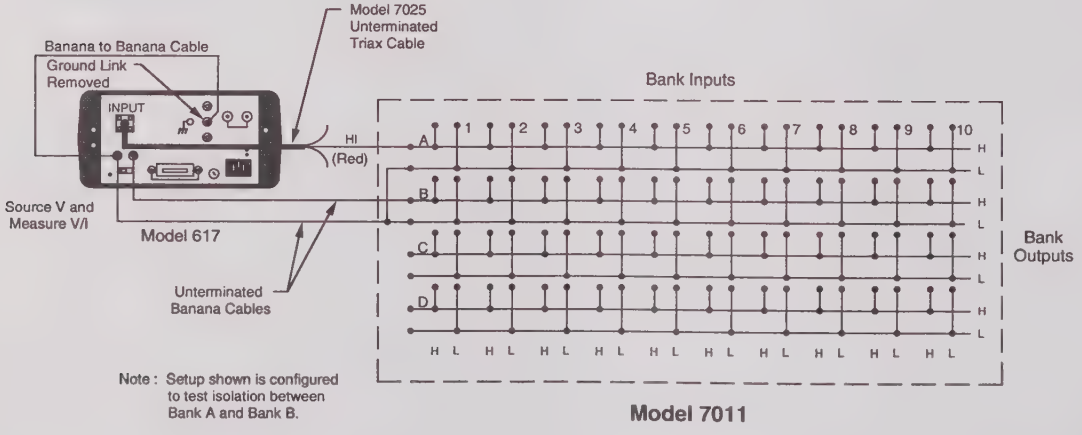


Figure 5-4
Bank isolation test connections

11. On the Model 617, disable zero check and press OPERATE to source +100V.
12. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$). This measurement is the leakage resistance (bank isolation) between Bank A, Input 1 and Bank B, Input 2.
13. Place the Model 617 voltage source in standby and enable zero check.
14. Turn off the Model 7001 and move the electrometer connections to Banks B and C.
15. Install the Model 7011 in slot 1 of the mainframe and turn the Model 7001 on.
16. Program the Model 7001 to close Channels 1!12 and 1!23 (Bank B, Input 2 and Bank C, Input 3).
17. On the Model 617, disable zero check and press OPERATE to source +100V.
18. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$).
19. Place the Model 617 voltage source in standby and enable zero check.
20. Turn off the Model 7001 and move the electrometer connections to Banks C and D.
21. Install the Model 7011 in slot 1 of the mainframe, and turn the Model 7001 on.
22. Using Table 5-2 as a guide, repeat the basic procedure of steps 16 through 18 for the rest of the path pairs (test numbers 3 through 9 in the table).
23. Place the Model 617 voltage source in standby and enable zero check.

NOTE

Refer to for the following procedure to check channel-to-channel isolation.

24. Turn off the Model 7001 and connect the Model 617 to the card as shown in Figure 5-5.
25. Install the Model 7011 in slot 1 of the Model 7001, and turn the mainframe on.
26. Program the Model 7001 to close Channel 1!2 (Bank A, Input 2). Make sure all other channels are open.
27. On the Model 617, disable zero check and press OPERATE to source 100V.
28. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$).
29. Place the Model 617 voltage source in standby, and enable zero check.
30. Using Table 5-3 as a guide, perform tests 2 through 9 for the remaining Bank A Inputs. Remember to move Bank Input connections as indicated in the table.
31. Use Table 5-3 (test numbers 10 through 36) and the above procedure to test Banks B, C, and D.

Table 5-2
Bank isolation test summary

Test number	Bank isolation	Test equipment location	Channels closed*
1	Bank A, Input 1 to Bank B, Input 2	Bank A and Bank B	1!1 and 1!12
2	Bank B, Input 2 to Bank C, Input 3	Bank B and Bank C	1!12 and 1!23
3	Bank C, Input 3 to Bank D, Input 4	Bank C and Bank D	1!23 and 1!34
4	Bank C, Input 4 to Bank D, Input 5	Bank C and Bank D	1!24 and 1!35
5	Bank C, Input 5 to Bank D, Input 6	Bank C and Bank D	1!25 and 1!36
6	Bank C, Input 6 to Bank D, Input 7	Bank C and Bank D	1!26 and 1!37
7	Bank C, Input 7 to Bank D, Input 8	Bank C and Bank D	1!27 and 1!38
8	Bank C, Input 8 to Bank D, Input 9	Bank C and Bank D	1!28 and 1!39
9	Bank C, Input 9 to Bank D, Input 10	Bank C and Bank D	1!29 and 1!40

*Assumes Model 7011 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

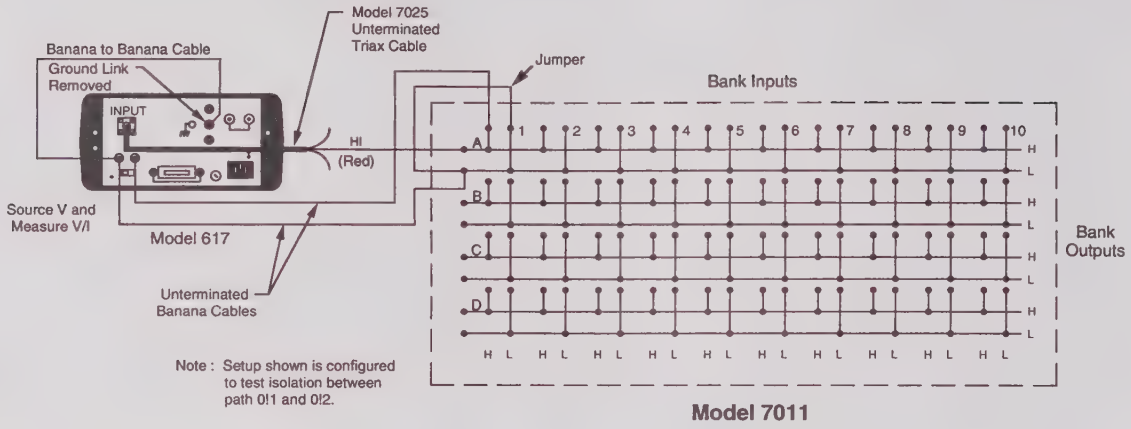


Figure 5-5
Channel-to-channel isolation test connections

Table 5-3
Channel-to-channel isolation test summary

Test number	Channel-to-channel isolation	Test equipment location	Channel closed*
1	Bank A, Input 1 to Bank A, Input 2	Bank A and Input 1	1!2
2	Bank A, Input 2 to Bank A, Input 3	Bank A and Input 2	1!3
3	Bank A, Input 3 to Bank A, Input 4	Bank A and Input 3	1!4
4	Bank A, Input 4 to Bank A, Input 5	Bank A and Input 4	1!5
5	Bank A, Input 5 to Bank A, Input 6	Bank A and Input 5	1!6
6	Bank A, Input 6 to Bank A, Input 7	Bank A and Input 6	1!7
7	Bank A, Input 7 to Bank A, Input 8	Bank A and Input 7	1!8
8	Bank A, Input 8 to Bank A, Input 9	Bank A and Input 8	1!9
9	Bank A, Input 9 to Bank A, Input 10	Bank A and Input 9	1!10
10	Bank B, Input 1 to Bank B, Input 2	Bank B and Input 1	1!12
11	Bank B, Input 2 to Bank B, Input 3	Bank B and Input 2	1!13
12	Bank B, Input 3 to Bank B, Input 4	Bank B and Input 3	1!14
13	Bank B, Input 4 to Bank B, Input 5	Bank B and Input 4	1!15
14	Bank B, Input 5 to Bank B, Input 6	Bank B and Input 5	1!16
15	Bank B, Input 6 to Bank B, Input 7	Bank B and Input 6	1!17
16	Bank B, Input 7 to Bank B, Input 8	Bank B and Input 7	1!18
17	Bank B, Input 8 to Bank B, Input 9	Bank B and Input 8	1!19
18	Bank B, Input 9 to Bank B, Input 10	Bank B and Input 9	1!20
19	Bank C, Input 1 to Bank C, Input 2	Bank C and Input 1	1!22
20	Bank C, Input 2 to Bank C, Input 3	Bank C and Input 2	1!23
21	Bank C, Input 3 to Bank C, Input 4	Bank C and Input 3	1!24
22	Bank C, Input 4 to Bank C, Input 5	Bank C and Input 4	1!25
23	Bank C, Input 5 to Bank C, Input 6	Bank C and Input 5	1!26
24	Bank C, Input 6 to Bank C, Input 7	Bank C and Input 6	1!27
25	Bank C, Input 7 to Bank C, Input 8	Bank C and Input 7	1!28
26	Bank C, Input 8 to Bank C, Input 9	Bank C and Input 8	1!29
27	Bank C, Input 9 to Bank C, Input 10	Bank C and Input 9	1!30
28	Bank D, Input 1 to Bank D, Input 2	Bank D and Input 1	1!32
29	Bank D, Input 2 to Bank D, Input 3	Bank D and Input 2	1!33
30	Bank D, Input 3 to Bank D, Input 4	Bank D and Input 3	1!34
31	Bank D, Input 4 to Bank D, Input 5	Bank D and Input 4	1!35
32	Bank D, Input 5 to Bank D, Input 6	Bank D and Input 5	1!36
33	Bank D, Input 6 to Bank D, Input 7	Bank D and Input 6	1!37
34	Bank D, Input 7 to Bank D, Input 8	Bank D and Input 7	1!38
35	Bank D, Input 8 to Bank D, Input 9	Bank D and Input 8	1!39
36	Bank D, Input 9 to Bank D, Input 10	Bank D and Input 9	1!40

*Assumes Model 7011 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

5.3.8 Differential and common-mode isolation tests

These tests check the leakage resistance (isolation) between HI (H) and LO (L) (differential), and from HI (H) and LO (L) to chassis (common-mode) of every bank and channel. In general, the test is performed by applying a voltage (100V) across the terminals and then measuring the leakage current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and current levels, and displays the resistance value.

Perform the following steps to check differential and common mode isolation:

1. Turn the Model 7001 off if it is on, and remove any jumpers and test leads connected to the multiplexer card.
2. Turn on the Model 617 and allow the unit to warm up for two hours for rated accuracy.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.

WARNING

The following steps use high voltage (100V). Be sure to remove power from the circuit before making connection changes.

4. On the Model 617, set the voltage source for +100V, and select the 200nA current range. Make sure the voltage source is still in standby.
5. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
6. With the Model 617 in standby, connect the electrometer to Bank A of the multiplexer card, as shown in Figure 5-6.
7. Install the Model 7011 in slot 1 (CARD 1) of the mainframe, and turn the Model 7001 on.
8. Make sure all the relays are open. (Press OPEN ALL on the Model 7001.)
9. On the Model 617, disable zero check, and press OPERATE to source 100V.
10. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ (10^9Ω). This measurement is the differential leakage resistance (isolation) of Bank A.
11. Place the Model 617 in standby and enable zero check.

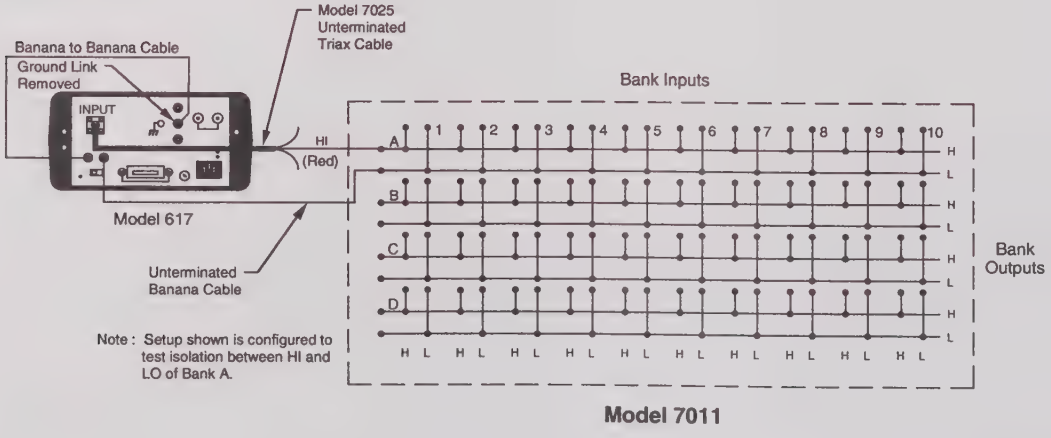


Figure 5-6
Differential isolation test connections

12. Program the Model 7001 to close Channel 1!1 (Bank A, Input 1).
13. On the Model 617, disable zero check and press OPERATE to source +100V.
14. After allowing the reading on the Model 617 to settle, verify that it is also >1GΩ (10^9Ω). This measurement checks the differential isolation of Input 1.
15. Using Table 5-4 as a guide, repeat the basic procedure in steps 11 through 14 to test Inputs 2 through 10 of Bank A (test numbers 3 through 11 of the table).
16. Use Table 5-4 (test numbers 12 through 42) and the above procedure to test Banks B, C and D.
17. Place the Model 617 voltage source in standby and enable zero check.

NOTE

Refer to Figure 5-7 for the following procedure to check common mode isolation.

18. Turn off the Model 7001, and connect the electrometer to the Model 7011 as shown in Figure 5-7.
19. Repeat steps 4 through 16 to check common mode isolation. Verify that each reading is >1GΩ (10^9Ω).

Table 5-4
Differential and common-mode isolation testing

Test number	Differential or common mode isolation	Channel closed*
1	Bank A	None
2	Bank A, Input 1	1!1
3	Bank A, Input 2	1!2
4	Bank A, Input 3	1!3
5	Bank A, Input 4	1!4
6	Bank A, Input 5	1!5
7	Bank A, Input 6	1!6
8	Bank A, Input 7	1!7
9	Bank A, Input 8	1!8
10	Bank A, Input 9	1!9
11	Bank A, Input 10	1!10
12	Bank B	None
13	Bank B, Input 1	1!11
14	Bank B, Input 2	1!12
15	Bank B, Input 3	1!13
16	Bank B, Input 4	1!14
17	Bank B, Input 5	1!15
18	Bank B, Input 6	1!16
19	Bank B, Input 7	1!17
20	Bank B, Input 8	1!18
21	Bank B, Input 9	1!19
22	Bank B, Input 10	1!20
23	Bank C	None
24	Bank C, Input 1	1!21
25	Bank C, Input 2	1!22
26	Bank C, Input 3	1!23
27	Bank C, Input 4	1!24
28	Bank C, Input 5	1!25
29	Bank C, Input 6	1!26
30	Bank C, Input 7	1!27
31	Bank C, Input 8	1!28
32	Bank C, Input 9	1!29
33	Bank C, Input 10	1!30
34	Bank D	None
35	Bank D, Input 1	1!31
36	Bank D, Input 2	1!32
37	Bank D, Input 3	1!33
38	Bank D, Input 4	1!34
39	Bank D, Input 5	1!35
40	Bank D, Input 6	1!36
41	Bank D, Input 7	1!37
42	Bank D, Input 8	1!38
43	Bank D, Input 9	1!39
44	Bank D, Input 10	1!40

*Assumes Model 7011 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

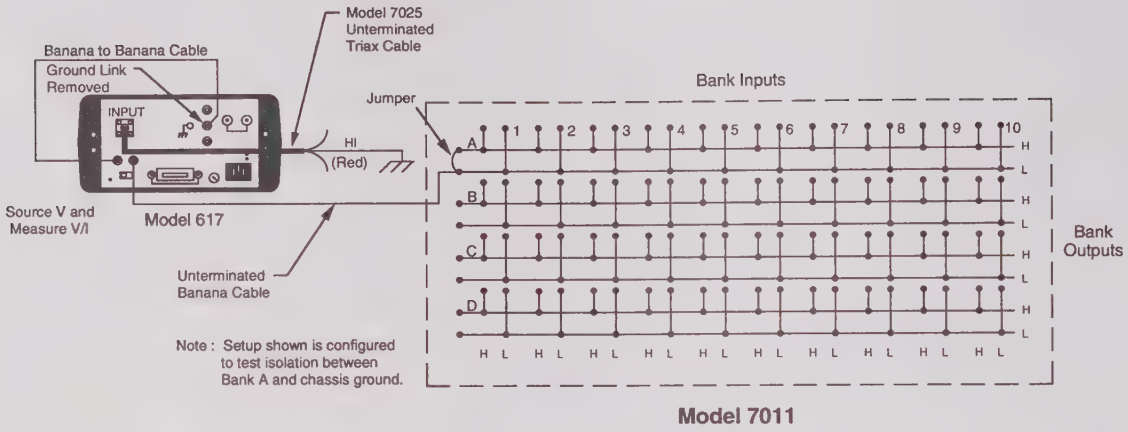


Figure 5-7
Common-mode isolation test connections

5.4 Special handling of static-sensitive devices

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high-impedance levels involved. When handling such devices, use the precautions listed below.

NOTE

In order to prevent damage, assume that all parts are static-sensitive.

1. Such devices should be transported and handled only in containers specially designed to prevent or dissipate static build-up. Typically, these devices will be received in anti-static containers made of plastic or foam. Keep these parts in their original containers until ready for installation or use.
2. Remove the devices from their protective containers only at a properly-grounded workstation. Also, ground yourself with an appropriate wrist strap while working with these devices.
3. Handle the devices only by the body; do not touch the pins or terminals.
4. Any printed circuit board into which the device is to be inserted must first be grounded to the bench or table.
5. Use only anti-static type de-soldering tools and grounded-tip soldering irons.

5.5 Principles of operation

The following paragraphs discuss the basic operating principles for the Model 7011, and can be used as an aid in troubleshooting the card. The schematic drawing of the card is shown on drawing number 7011-106, located at the end of Section 6.

5.5.1 Block diagram

Figure 5-8 shows a simplified block diagram of the Model 7011. Key elements include the relay drivers and relays, as well as the ROM, which contains card ID and configuration information. These various elements are discussed in the following paragraphs.

5.5.2 ID data circuits

Upon power-up, card identification information from each card is read by the mainframe. This ID data includes such information as card ID, hardware settling time, and relay configuration information.

ID data is contained within an on-card EEPROM (U105). In order to read this information, the sequence described below is performed on power-up.

1. The IDDATA line (pin 6 of U105) is set from high to low while the IDCLK line (pin 5 of U105) is held high. This action initiates a start command to the ROM to transmit data serially to the mainframe (Figure 5-9).
2. The mainframe sends the ROM address location to be read over the IDDATA line. The ROM then transmits an acknowledge signal back to the mainframe, and it then transmits data at that location back to the mainframe (Figure 5-10).
3. The mainframe then transmits an acknowledge signal, indicating that it requires more data. The ROM will then sequentially transmit data after each acknowledge signal it receives.
4. Once all data is received, the mainframe sends a stop command, which is a low-to-high transition of the IDDATA line with the IDCLK line held high (see Figure 5-9).

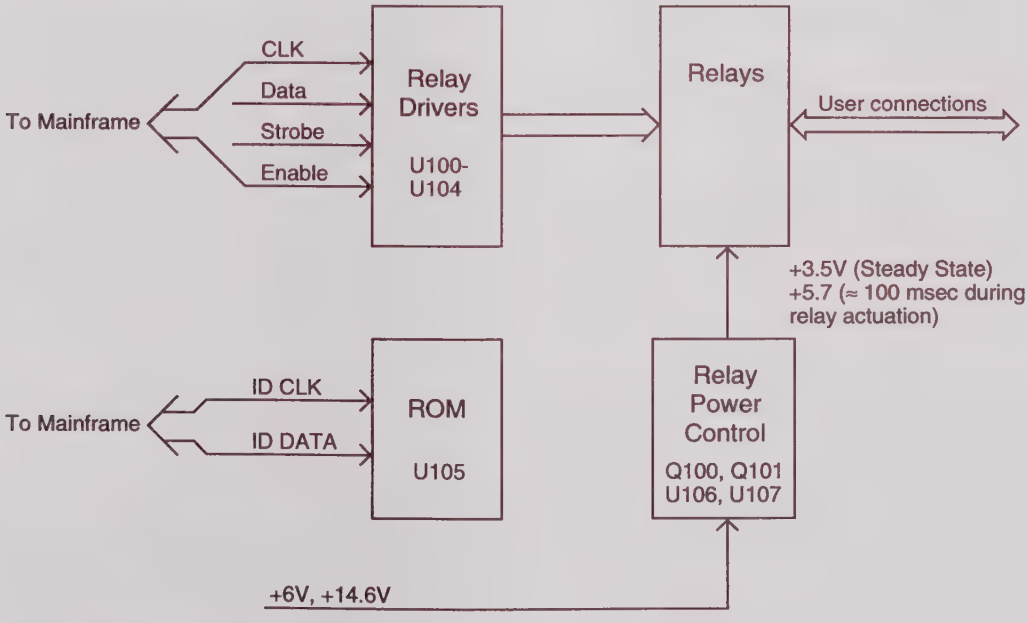


Figure 5-8
Model 7011 block diagram

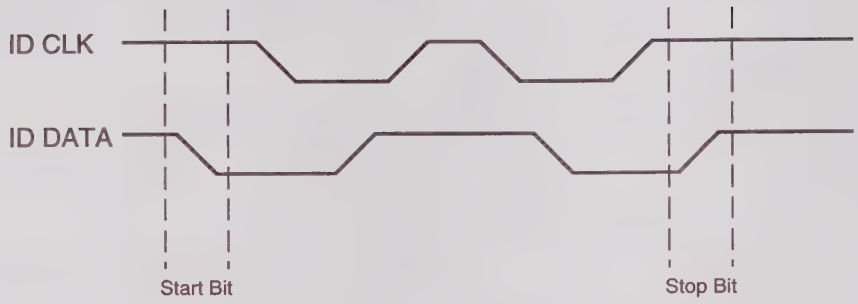


Figure 5-9
Start and stop sequences

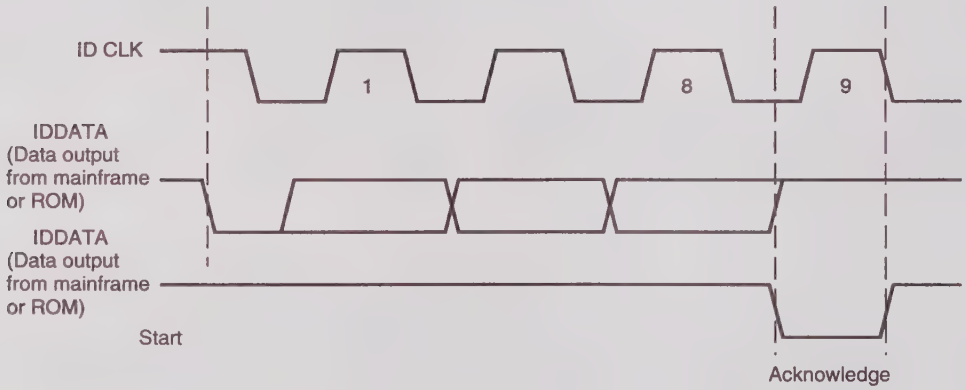


Figure 5-10
Transmit and acknowledge sequence

5.5.3 Relay control

Card relays are controlled by serial data transmitted via the relay DATA line. A total of five bytes for each card are shifted in serial fashion into latches located in the card relay driver ICs. The serial data is clocked in by the CLK line. As data overflows one register, it is fed out the Q'S line of the register down the chain.

Once all five bytes have shifted into the card, the STROBE line is set high to latch the relay information into the Q outputs of the relay drivers, and the appropriate relays are energized (assuming the driver outputs are enabled, as discussed below). Note that a relay driver output goes low to energize the corresponding relay.

5.5.4 Relay power control

A relay power control circuit, made up of U106, U107, Q100, Q101, and associated components, keeps power dissipated in relay coils at a minimum, thus reducing possible problems caused by thermal EMFs.

During steady-state operation, the relay supply voltage, +V, is regulated to +3.5V to minimize coil power dissipation. When a relay is first closed, the STROBE pulse applied to U106 changes the parameters of the relay supply voltage regulator, Q100, allowing the relay supply voltage, +V, to rise to +5.7V for about 100msec. This brief voltage rise ensures that relays close as quickly as possible. After the 100msec period has elapsed, the relay supply voltage (+V) drops back down to its nominal steady-state value of +3.5V.

5.5.5 Power-on safeguard

NOTE

The power-on safeguard circuit discussed below is actually located on the digital board in the Model 7001 mainframe.

A power-on safeguard circuit, made up of U114 (a D-type flip-flop) and associated components ensures that relays do not randomly energize on power-up and power-down. This circuit disables all relays (all relays are open) during power-up and power-down periods.

The PRESET line on the D-type flip-flop is controlled by the 68302 microprocessor, while the CLK line of the D-type flip-flop is controlled by a VIA port line on the 68302 processor. The Q output of the flip-flop drives each switch card relay driver IC enable pin (U100-U104, pin 8).

When the 68302 microprocessor is in the reset mode, the flip-flop PRESET line is held low, and Q out immediately goes high, disabling all relays (relay driver IC enable pins are high, disabling the relays). After the reset condition elapses (≈200msec), PRESET goes high while Q out stays high. When the first valid STROBE pulse occurs, a low logic level is clocked into the D-type flip-flop, setting Q out low and enabling all relay drivers simultaneously. Note that Q out stays low, (enabling relay drivers) until the 68302 processor goes into a reset condition.

5.6 Troubleshooting

5.6.1 Troubleshooting equipment

Table 5-5 summarizes recommended equipment for troubleshooting the Model 7011.

Table 5-5
Recommended troubleshooting equipment

Description	Manufacturer and model	Application
Multimeter	Keithley 196	Measure DC voltages
Oscilloscope	TEK 2243	View logic waveforms

5.6.2 Troubleshooting access

In order to gain access to the relay card top surface to measure voltages under actual operation conditions, perform the following steps:

1. Disconnect the connector card from the relay card.
2. Remove the Model 7001 cover.
3. Install the relay card in the CARD 1 slot location.
4. Turn on Model 7001 power to measure voltages (see following paragraph).

5.6.3 Troubleshooting Procedure

Table 5-6 summarizes switch card troubleshooting.

WARNING

Lethal voltages are present within the 7001 mainframe. Some of the procedures may expose you to hazardous voltages. Observe standard safety precautions for dealing with live circuits. Failure to do so could result in personal injury or death.

CAUTION

Observe the following precautions when troubleshooting or repairing the switch card:

To avoid contamination, which could degrade card performance, always handle the card only by the handle and side edges. Do not touch edge connectors, board surfaces, or components on the card. Also, do not touch areas adjacent to electrical contacts on connectors.

Use care when removing relays from the PC board to avoid pulling traces away from the circuit board. Before attempting to remove a relay, use an appropriate de-soldering tool, such as a solder sucker, to clear each mounting hole completely free of solder. Each relay pin must be free to move in its mounting hole before removal. Also, make certain that no burrs are present on the ends of the relay pins.

Table 5-6
Troubleshooting procedure

Step	Item/component	Required condition	Comments
1	GND pad		All voltages referenced to digital ground (GND pad).
2	+6V pad	+6VDC	Relay voltage.
3	+5V pad	+5VDC	Logic voltage.
4	+14.6V pad	+14.6VDC	Relay bias voltage.
5	+V pad	+3.5VDC*	Regulated relay voltage.
6	U105, pin 5	ID CLK pulses	During power-up only.
7	U105, pin 6	ID DATA pulses	During power-up only.
8	U100, pin 7	STROBE pulse	End of relay update sequence.
9	U100, pin 2	CLK pulses	During relay update sequence only.
10	U100, pin 3	DATA pulses	During relay update sequence only.
11	U100-U104, pins 10-18	Low with relay energized; high with relay de-energized.	Relay driver outputs.

*+3.5VDC present at +V pad under steady-state conditions. This voltage rises to +5.7VDC for about 100msec when relay configuration is changed.

6
Replaceable Parts

6.1 Introduction

This section contains replacement parts information, schematic diagrams, and component layout drawings for the Model 7011.

6.2 Parts lists

Parts lists for the various circuit boards are included in tables integrated with schematic diagrams and component layout drawings for the boards. Parts are listed alphabetically in order of circuit designation.

6.3 Ordering information

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory (see inside front cover for addresses). When ordering parts, be sure to include the following information:

1. Card model number 7011
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

6.4 Factory service

If the card is to be returned to Keithley Instruments for repair, perform the following:

1. Complete the service form at the back of this manual and include it with the card.
2. Carefully pack the card in the original packing carton.
3. Write ATTENTION REPAIR DEPT on the shipping label.

Note: It is not necessary to return the matrix mainframe with the card.

6.5 Component layouts and schematic diagrams

Component layout drawings and schematic diagrams are included on the following pages integrated with the parts lists:

Table 1 Parts List, Relay Card for 7011-S and 7011-C.
7011-100 Component Layout, Relay Card for 7011-S and 7011-C.
7011-106 Schematic, Relay Card for 7011-S and 7011-C.

NOTE

The Model 7011 and 7012 use the same relay card, only the connector cards are different.

Table 2 Parts List, Screw Terminated Connector Card for 7011-S.
7011-160 Component Layout, Screw Terminated Connector Card for 7011-S.
7011-166 Schematic, Screw Terminated Connector Card for 7011-S.

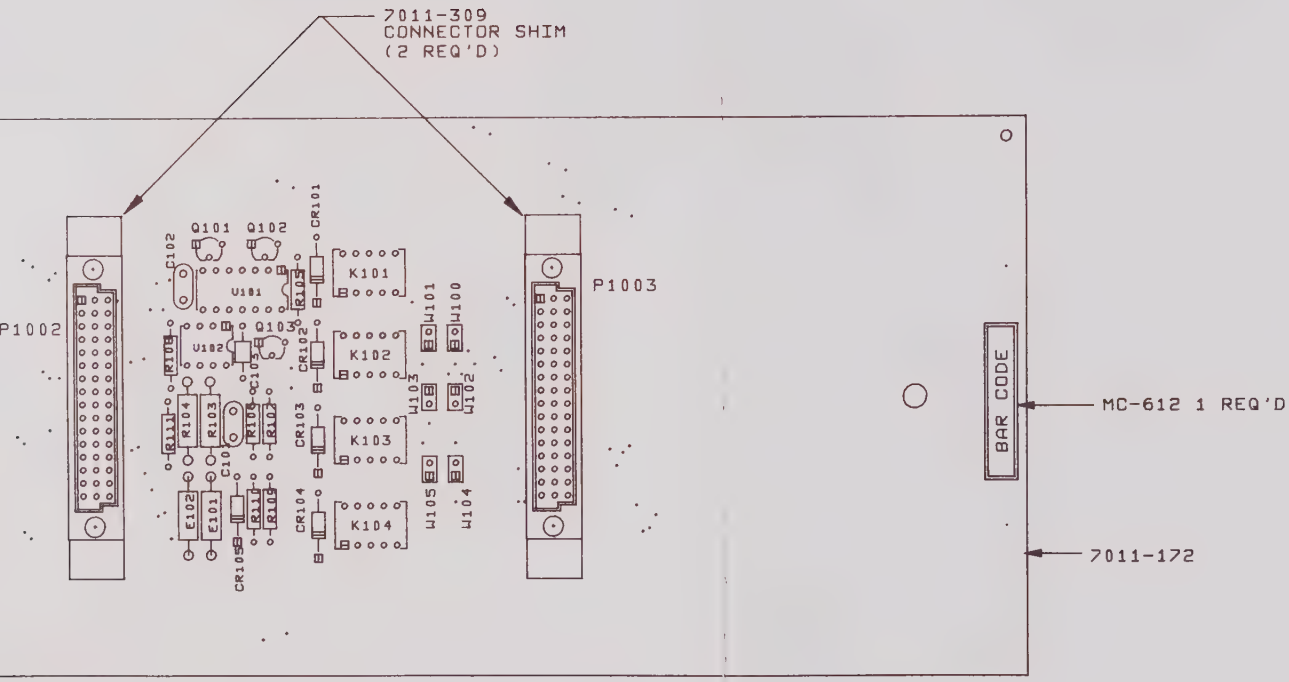
Table 3 Parts List, Mass Terminated Connector Card for 7011-C.
7011-170 Component Layout, Mass Terminated Connector Card for 7011-C.
7011-176 Schematic, Mass Terminated Connector Card for 7011-C.

Model 7011 Parts List

Circuit Desig.	Description	Keithley Part No.
	BRACKET	7011-307
	STANDOFF	ST-203-1
	SHIELD	7011-311A
	CONNECTOR SHIM	7011-309A
	CONN,BERG	CS-339
	CONNECTOR, JUMPER	CS-476
	JUMPER FOR W100-105	
C101,102	CAP,1UF,20%,50V, CERAMIC	C-237-1
C103	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
CR101-105	DIODE,SILICON,IN4148 (DO-35)	RF-28
E101,102	FERRITE BEAD	CT-8
J1004	CONN, 96-PIN, 3 ROWS	CS-514
K101-104	RELAY, ULTRA-SMALL POLARIZED TF2E-4.5V	RL-162
P1002,1003	CONNECTOR, FEMALE	CS-748-3
Q101-103	TRANS,N CHAN MOSPOW FET,V11713 (TO-92)	TG-195
R103,104	R-1-1M	
R105	R-76-39	
R106	RES,10,5%,1/4W,COMPOSITION OR FILM	R-76-10
R107	RES,4.99K,1%,1/8W,METAL FILM	R-88-4.99K
R108,110	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R109	RES,100K,5%,1/4W,COMPOSITION OR FILM	R-76-100K
R111	RES,10K,1%,1/8W,METAL FILM	R-88-10K
U101	IC,QUAD 2 INPUT NOR,74HC02	IC-412
U102	IC, DUAL COMP,LM393	IC-343
W100-105	CONN,BERG,2 PIN	CS-339-2

A
B
NO.7011-170
1
2
3
4
5
6
J1004
A
B

LTR.	ECO NO.	REVISION	ENG.	DATE
B		RELEASED		

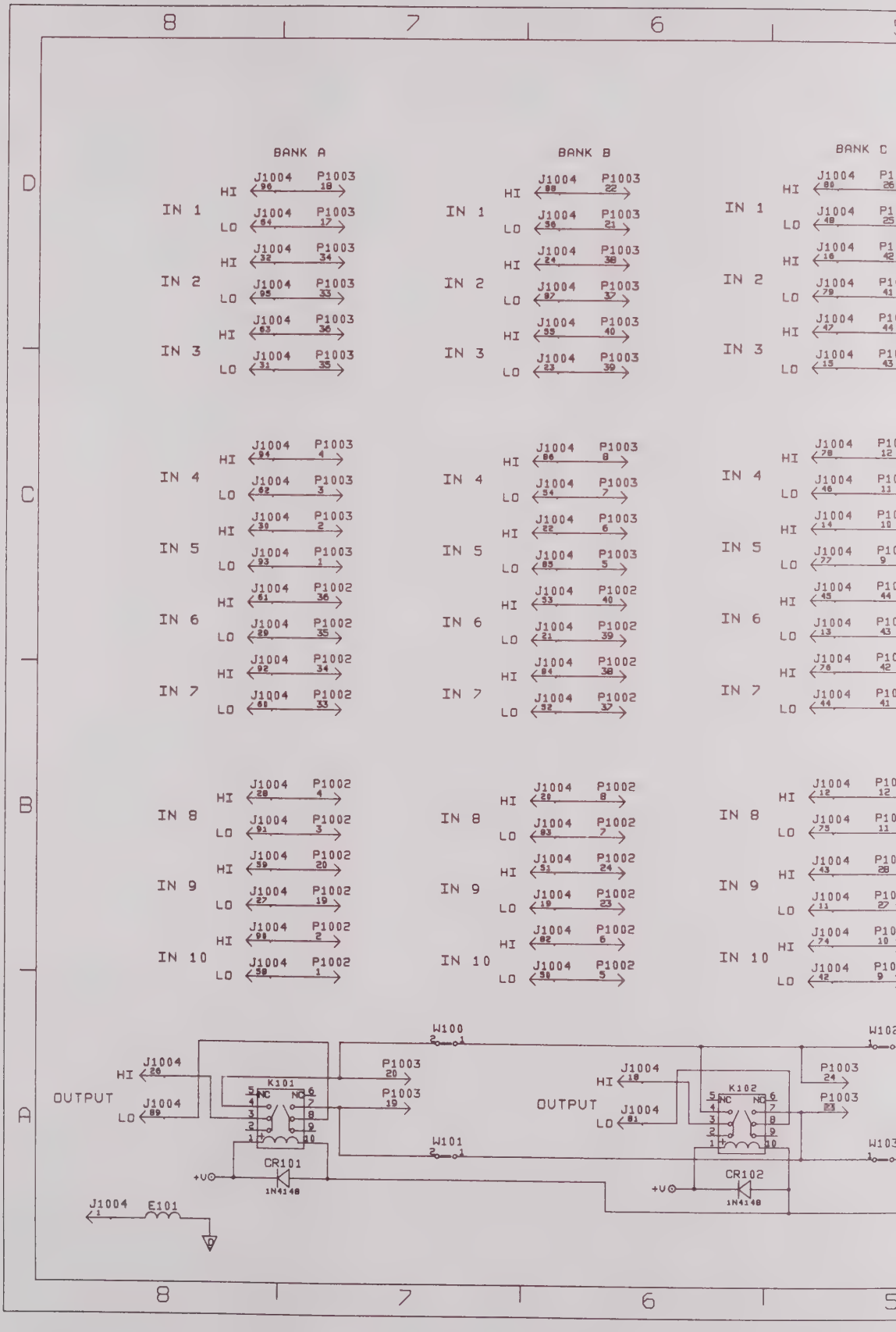


NOTE: FOR COMPONENT INFORMATION
REFER TO PRODUCT STRUCTURE.

MODEL	NEXT ASSEMBLY	QTY.
7011		

USED ON

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 12/18/91	SCALE 1:1	TITLE COMPONENT LAYOUT, MASS TERM. CARD
KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=±.015 ANG.=±1°	DRN. MAH	ENG. APPR.	
	XXX=±.005 FRAC.=±1/64	MATERIAL		C NO. 7011-170
	SURFACE MAX. 63	FINISH		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BANK B
BANK C
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
IN 8
IN 9
IN 10
HI
LO
J1004
P1003
P1002
OUTPUT
K101
K102
CR101
CR102
1N4148
W100
W101
W102
W103
E101
+V

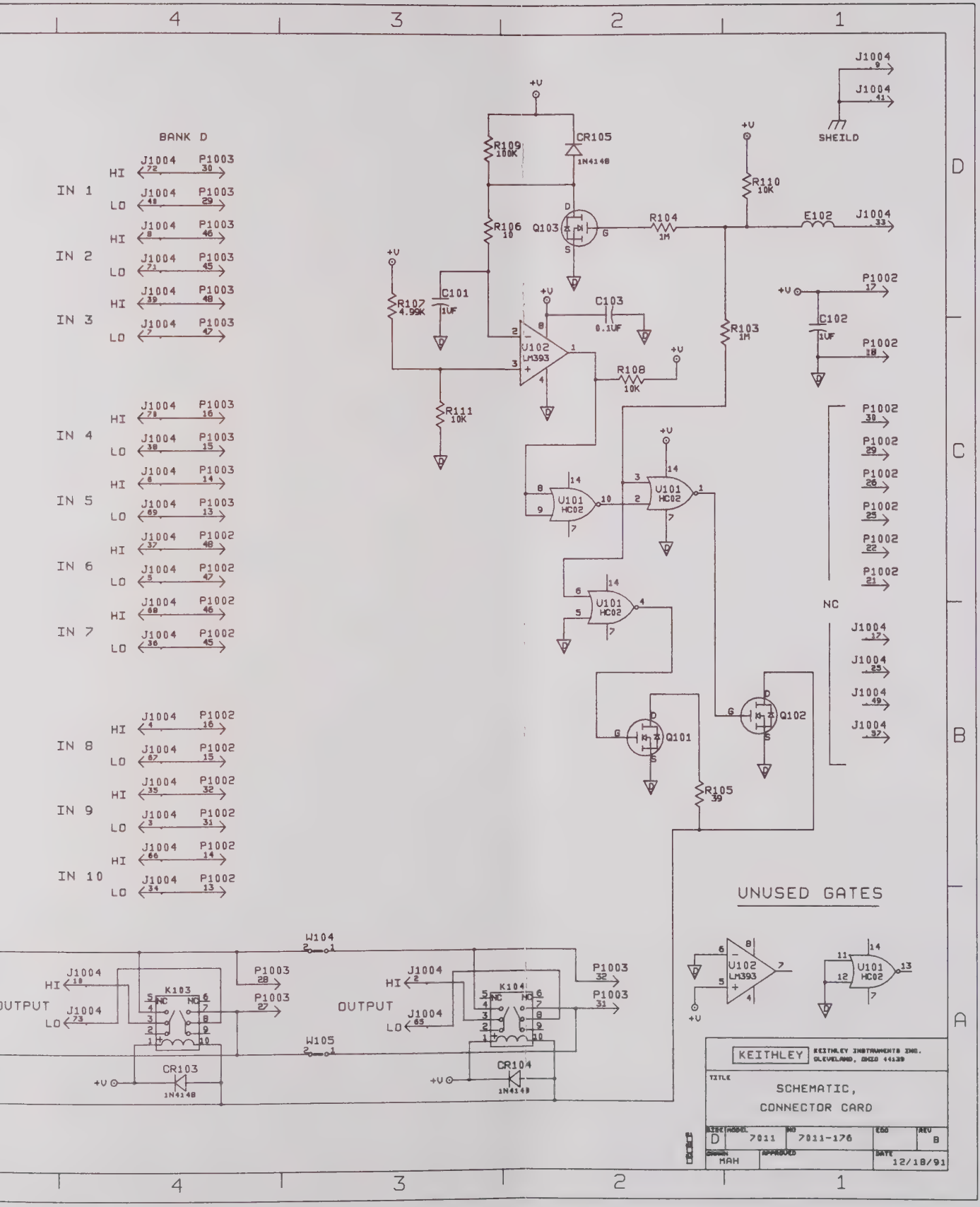
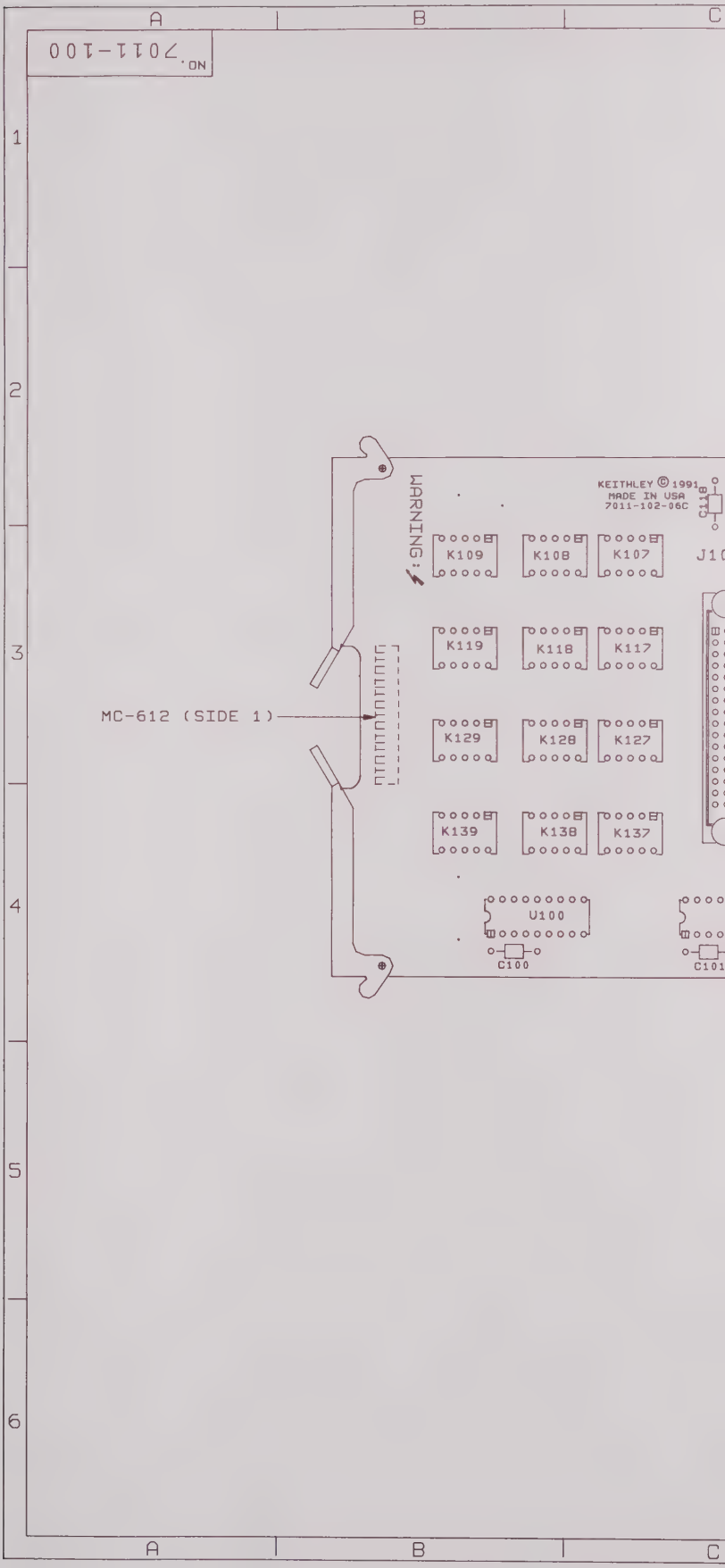

BANK D
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
IN 8
IN 9
IN 10
HI
LO
J1004
P1003
P1002
R109 100K
CR105 1N4148
R110 10K
R106 10
Q103
R104 1M
E102
SHEILD
R107 4.99K
C101 1UF
C103 0.1UF
U102 LM393
R108 10K
R111 10K
R103 1M
C102 1UF
U101 HC02
Q101
Q102
R105 39
NC
UNUSED GATES
W104
W105
K103
K104
OUTPUT
CR103
CR104
1N4148
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
SCHEMATIC,
CONNECTOR CARD
SIZE D
MODEL 7011
NO 7011-176
REV B
DRAWN MAH
APPROVED
DATE 12/18/91

Table 1. Relay Board for Model 7011-S and 7011-C, Parts List

	EJECTOR ARM	7011-301
	ROLL PIN (FOR EJECTOR ARMS)	DP-6-1
	SHIELD	7011-305
	SOCKET (FOR U105)	SO-72
	2-56X1/4 PHILLIPS PAN HD (FOR SCANNER SHIELD)	2-56X1/4PPH
	2-56X3/8 PHILLIPS PAN HEAD (P2001 TO STANDOFF)	2-56X3/8PPH
	4-40X1/4 PHILLIPS PAN HD SEMS SCREW (SCANNER BD TO TERMINAL BD)	4-40X1/4PPHSEM
	4-40X3/16 PHIL. PAN HD SEMS (FOR Q100)	4-40X3/16PPHSEM
C100-105,107, 108,109,118,119	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
C106	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
C110,111	CAP,1UF,20%,50V, CERAMIC	C-237-1
C112	CAP, 0.001uF, 20%, 500V, CERAMIC	C-22-.001
C113,114	CAP, 10UF,-20+100%,25V,ALUM ELEC	C-314-10
C115-117	CAP,150PF,10%,1000V,CERAMIC	C-64-150P
J1002,1003	CONNECTOR, MALE	CS-736-2
K100-139	RELAY, ULTRA-SMALL POLARIZED TF2E-5V	RL-149
P2001	CONNECTOR, RIGHT ANGLE MALE	CS-775-1
Q100	TRANS, NPN PWR, TIP31, (TO-220AB)	TG-253
Q101	TRANS,N CHAN MOSPOW FET,V11713 (TO-92)	TG-195
R100	RES, 2.49K, 1%, 1/8W, METAL FILM	R-88-2.49K
R101	RES, 1.15K, 1%, 1/8W, METAL FILM	R-88-1.15K
R102,103	RES, 560, 10%, 1/2W, COMPOSITION	R-1-560
R104	RES,1K,1%,1/8W,METAL FILM	R-88-1K
R105	RES,220K,5%,1/4W,COMPOSITION OR FILM	R-76-220K
R106	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
U100-104	IC, 8-BIT SERIAL-IN LATCH DRIVER, 5841A	IC-536
U105	EPROM PROGRAM	7011-800-***
U106	IC,RETRIG MONO MULTIVIB,74HC123	IC-492
U107	IC,AJD SHUNT REGULATOR,TL431CLP	IC-677
W100-107	JUMPER	J-15

*** Order current firmware revision level.


A
B
C
1
2
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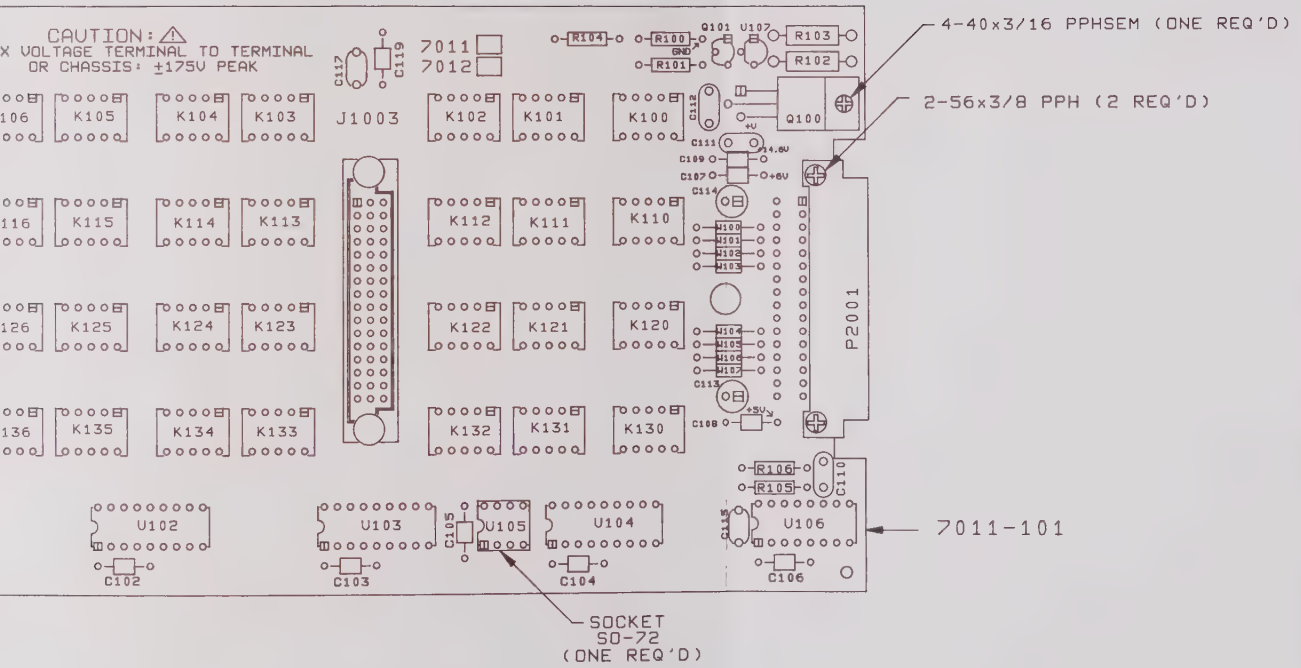
6
NO. 7011-100
KEITHLEY © 1991
MADE IN USA
7011-102-06C
WARNING:
K109
K108
K107
K119
K118
K117
K129
K128
K127
K139
K138
K137
U100
C100
MC-612 (SIDE 1)

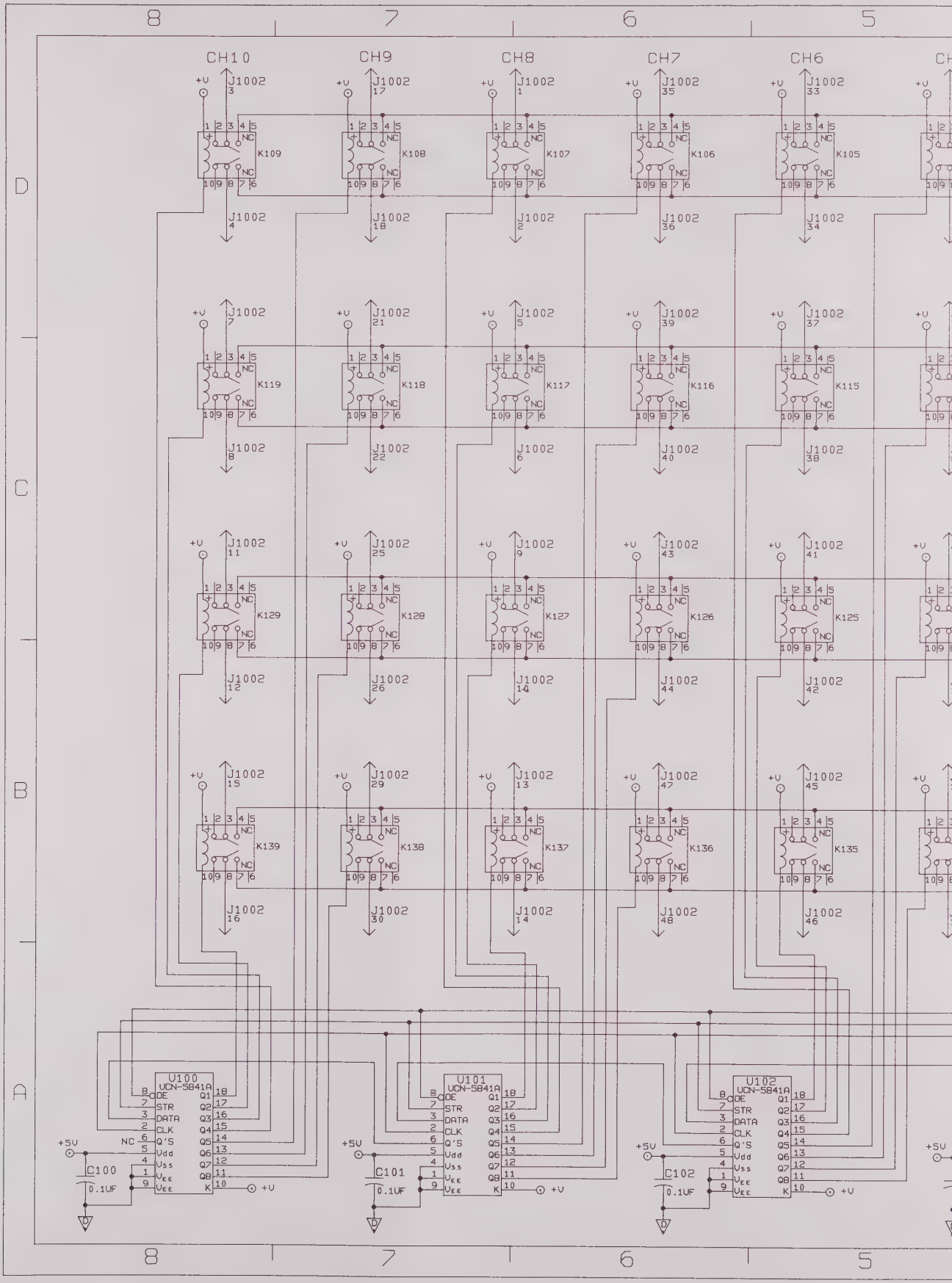
LTR.	ECO NO.	REVISION	ENG.	DATE
B		PRELIMINARY		
C	910920	RELEASED	MS	9-20-91



NOTE: FOR COMPONENT INFORMATION, REFER TO PRODUCT STRUCTURE

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 8/12/91	SCALE 5:4	TITLE: COMPONENT LAYOUT SCANNER BOARD
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=±.015 ANG.=±1°	DRN. KEK	ENG. APPR.	
	XXX=±.005 FRAC.=±1/64	MATERIAL	C	NO. 7011-100
	SURFACE MAX. 63	FINISH		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CH7
CH6
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K107
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K105
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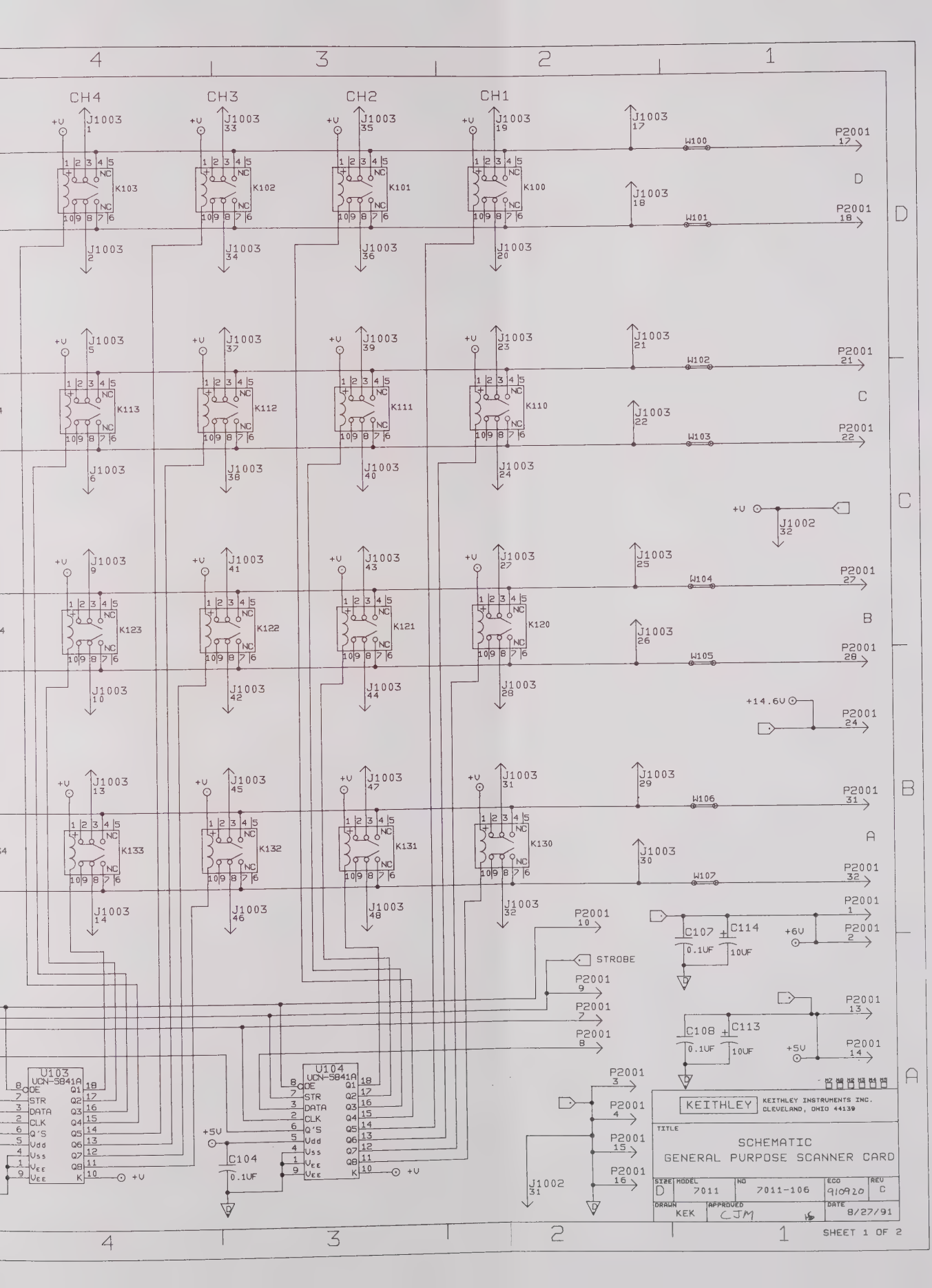
K115
K129
K128
K127
K126
K125
K139
K138
K137
K136
K135
U100
U101
U102
VCN-5841A
OE
STR
DATA
CLK
Q'S
Vdd
Vss
VEE
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
K
NC
+5V
C100
C101
C102
0.1UF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CH3
CH2
CH1
K103
K102
K101
K100
K113
K112
K111
K110
K123
K122
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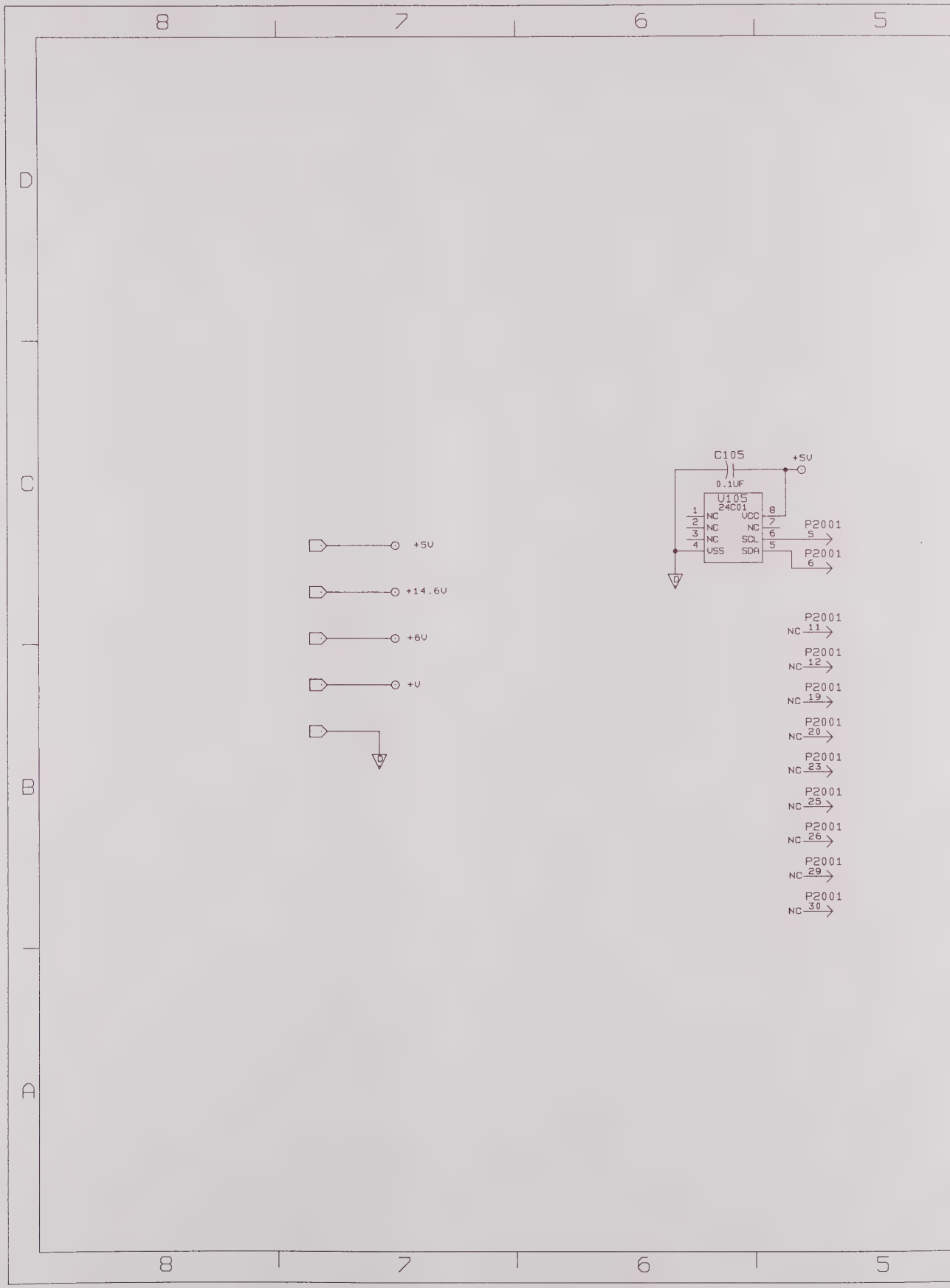
K133
K132
K131
K130
W100
W101
W102
W103
W104
W105
W106
W107
P2001
J1003
J1002
+U
+14.6V
+6V
+5V
STROBE
C107
C114
C108
C113
C104
0.1UF
10UF
U103
U104
VCN-5841A
OE
STR
DATA
CLK
Q'S
Vdd
Vss
VEE
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
TITLE
SCHEMATIC
GENERAL PURPOSE SCANNER CARD
SIZE D
MODEL 7011
NO 7011-106
ECO 910920
REV C
DRAWN KEK
APPROVED CJM
DATE 8/27/91
SHEET 1 OF 2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7
6
5
D
C
B
A
C105
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+5V
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24C01
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2 NC
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VCC 8
NC 7
SCL 6
SDA 5
P2001 5
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+14.6V
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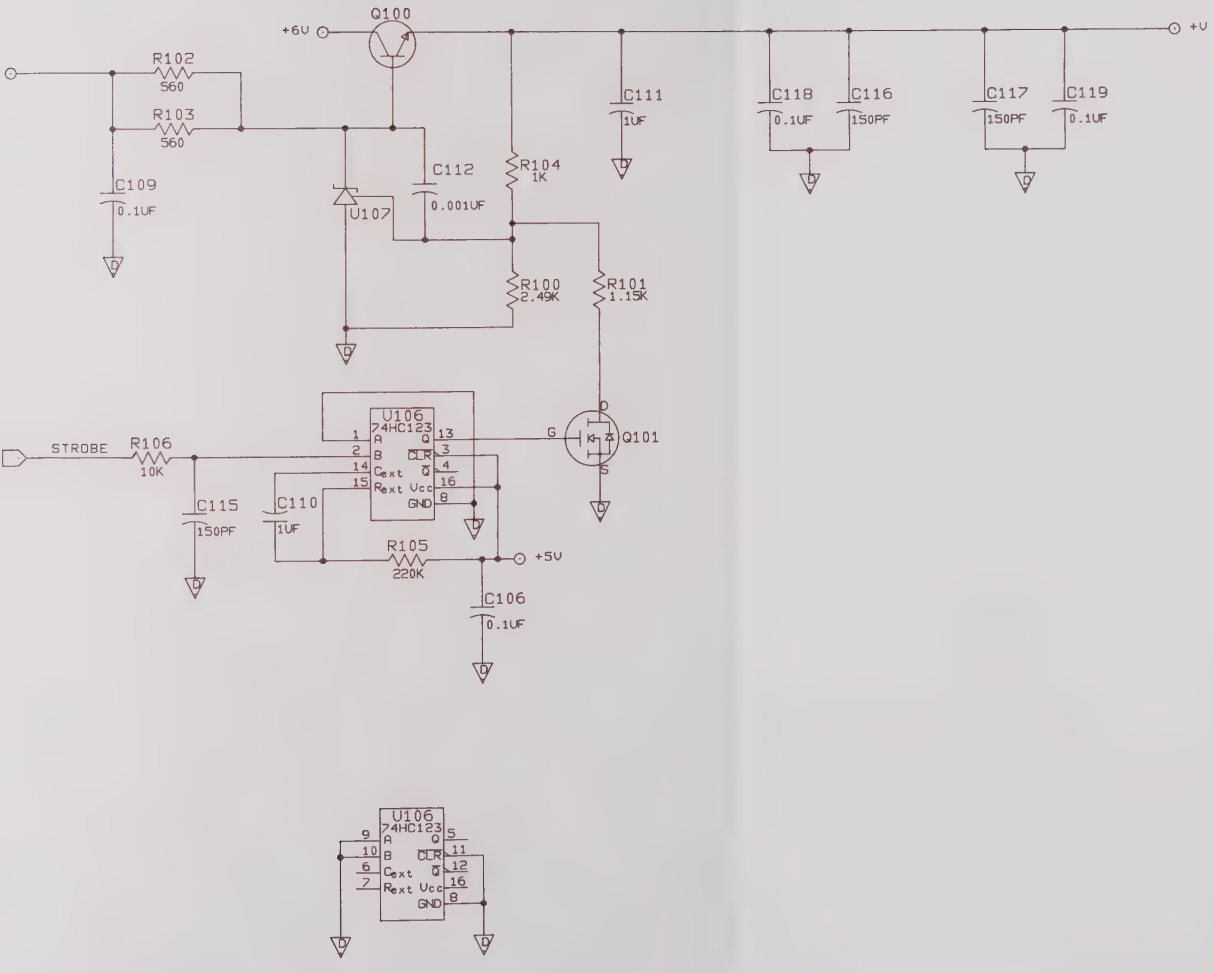


KEITHLEY — KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

TITLE

SCHEMATIC
GENERAL PURPOSE SCANNER CARD

SIZE	MODEL	NO	ECO	REV
D	7011	7011-106	910920	C

DRAWN	APPROVED	DATE
KEK	CJM	8/27/91

SHEET 2 OF 2

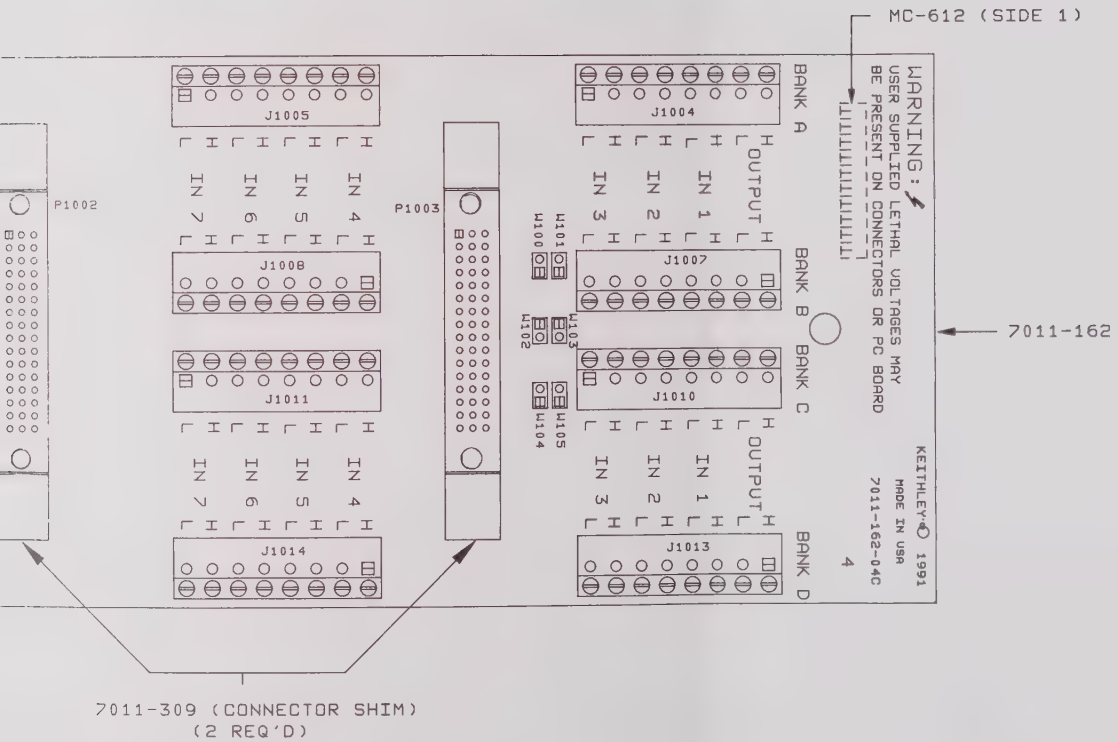
Table 2. Screw Terminal Board for Model 7011-S, Parts List

	CABLE CLAMP	7011-304-1
	CAPTIVE SCREW (FOR TOP CLAMP)	FA-243-1
	CONNECTOR, JUMPER (FOR CS-339-2)	CS-476
	CONNECTOR SHIM (FOR P1002, 1003)	7011-309
	SHIELD	7011-305
	STRIP, POLYURETHANE (FOR BOTTOM CLAMP)	2001-345-1
	TOP CLAMP	7011-302
	2-56X7/16 PHILLIPS PAN HEAD (FOR TERMINAL BOARD)	2-56X7/16PPH
J1011,1013,1014	CONN, 8 PIN	TE-115-8
J1004,1005,1007, 1008,1010	CONN, 8 PIN	TE-115-8
J1006,1009,1012, 1015	CONN, 6 PIN	TE-115-6
P1002,1003	CONNECTOR, FEMALE	CS-748-3
W100-105	CONN,BERG,2 PIN	CS-339-2

NO. 7011-160

7011-302 (TOP CLAMP)
7011-304-1 (CLAMP SILKSCREEN)
2001-345-1 (POLYURETHANE STRIP)
FA-243-1 (CAPTIVE PANEL SCREW)

LTR.	ECO NO.	REVISION	ENG.	DATE
B		PRELIMINARY		
C	910920	RELEASED	MS	9-20-91



7011-309 (CONNECTOR SHIM)
(2 REQ'D)

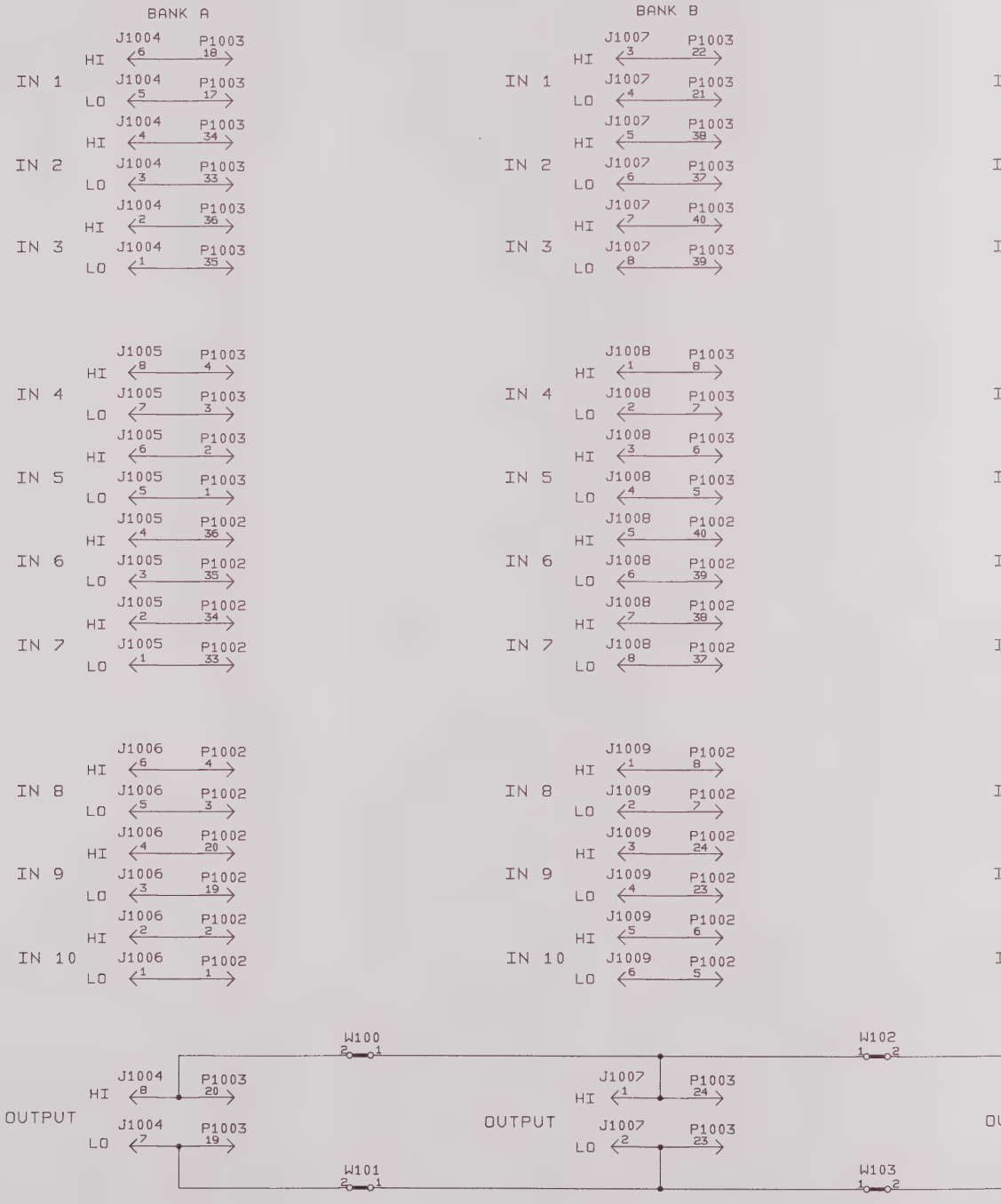
NOTE: FOR COMPONENT INFORMATION, REFER TO PRODUCT STRUCTURE

MODEL	NEXT ASSEMBLY	QTY.
	USED ON	

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 8/12/91	SCALE 5:4
	XX=±.015 ANG.=±1°	DRN. KEK	ENG. APPR.
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XXX=±.005 FRAC.=±1/64	MATERIAL	
	SURFACE MAX. 63	FINISH	

TITLE: COMPONENT LAYOUT TERMINAL BLOCK BOARD

C NO. 7011-160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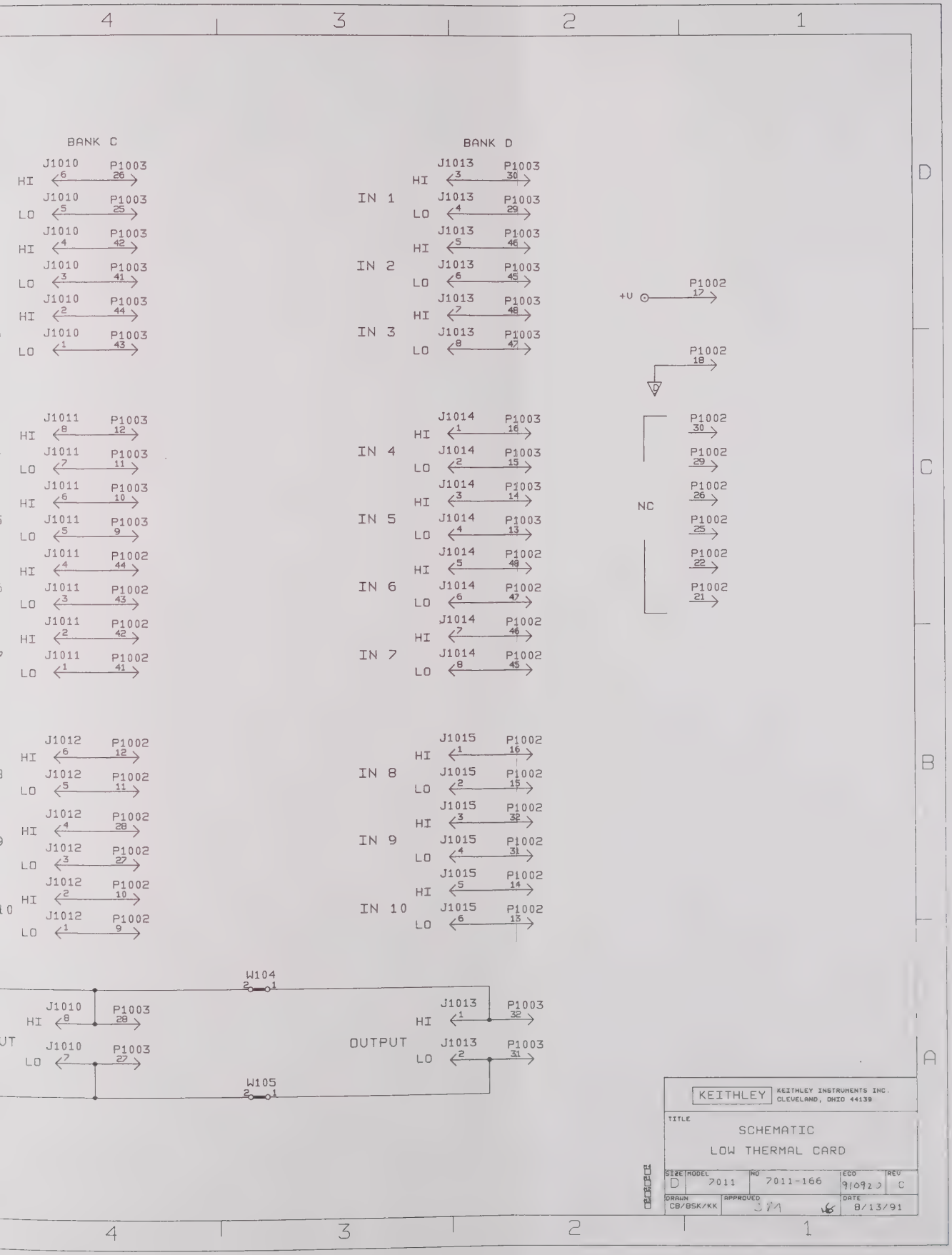
BANK B
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
IN 8
IN 9
IN 10
HI
LO
J1004
J1005
J1006
J1007
J1008
J1009
P1003
P1002
OUTPUT
W100
W101
W102
W103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HI 6 26
LO 5 25
HI 4 42
LO 3 41
HI 2 44
LO 1 43
J1011 P1003
HI 8 12
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HI 6 10
LO 5 9
J1011 P1002
HI 4 44
LO 3 43
HI 2 42
LO 1 41
J1012 P1002
HI 6 12
LO 5 11
HI 4 28
LO 3 27
HI 2 10
LO 1 9
W104
2 1
J1010 P1003
HI 8 28
UT
J1010 P1003
LO 7 27
W105
2 1
BANK D
J1013 P1003
HI 3 30
IN 1
LO 4 29
HI 5 46
IN 2
LO 6 45
HI 7 48
IN 3
LO 8 47
J1014 P1003
HI 1 16
IN 4
LO 2 15
HI 3 14
IN 5
LO 4 13
J1014 P1002
HI 5 48
IN 6
LO 6 47
HI 7 46
IN 7
LO 8 45
J1015 P1002
HI 1 16
IN 8
LO 2 15
HI 3 32
IN 9
LO 4 31
HI 5 14
IN 10
LO 6 13
J1013 P1003
HI 1 32
OUTPUT
LO 2 31
+U
P1002 17
P1002 18
P1002 30
P1002 29
NC
P1002 26
P1002 25
P1002 22
P1002 21
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
TITLE
SCHEMATIC
LOW THERMAL CARD
SIZE D
MODEL 7011
NO 7011-166
ECO 91092
REV C
DRAWN CB/BSK/KK
APPROVED
DATE 8/13/91

KEITHLEY INSTRUMENTS

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

- ❑ Intermittent
- ❑ IEEE failure
- ❑ Front panel operational
- ❑ Analog output follows display
- ❑ Obvious problem on power-up
- ❑ All ranges or functions are bad
- ❑ Particular range or function bad; specify _____
- ❑ Batteries and fuses are OK
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unstable
- ❑ Overload
- ❑ Unable to zero
- ❑ Will not read applied input

- ❑ Calibration only
- ❑ Data required
- ❑ Certificate of calibration required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.

KEITHLEY INSTRUMENTS

Keithley Instruments, Inc.
Instruments Division
28775 Aurora Road
Cleveland, Ohio 44139

www.manualsplus.com
1019081